Water Plant Optimization Study

LEAMINGTON/UNION WATER SYSTEM

May 1991

Ontario
Environment
Environnement

ISBN 0-7729-3283-2

WATER PLANT OPTIMIZATION STUDY

Leamington
Union Water System

Project No. 7-2025

May 1991

Cette publication technique
n'est disponible qu'en anglais.

PIBS 1554
log 89-2302-124

Study conducted by:

D.S. Madill
of
LaFontaine, Cowie, Buratto & Associates Limited

Under the direction of the
Leamington Project Committee:

Ron Hunsinger	- MOE Water Resources Branch
Dick Brown	- MOE Southwest Region
Bill Allsop	- MOE Union Water System
Bill Gregson	- MOE Project Engineering Branch
Janusz Budziakowski	- MOE Environmental Approvals Branch
Gerry Sigal	- R.V. Anderson Associates Limited

Address all correspondence to:

Ministry of the Environment
Water Resources Branch
1 St. Clair Ave. W., 4th Floor
Toronto, Ontario
M4V 1K6

Please note that some of the recommendations contained in this report may have already been completed at time of publication. For more information, please contact the local municipality, or the Water Resources Branch of the Ministry of the Environment.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The purpose of the Water Plant Optimization Study is to prepare a document that describes the present condition of a water plant with respect to operation as well as information regarding the quantity and quality of raw and finished water. The report attempts to make recommendations that will allow the plant to operate in an optimum condition so that the best possible finished water quality is achieved with emphasis on particulate removal and disinfection. The approach is to optimize the existing facilities and make recommendations for short term and long term improvements. It is anticipated that the optimization study documents will be updated annually.

The Union Water Treatment Plant is very well run and the finished water quality is very good. Although it might be difficult to improve on finished water quality with the existing equipment, the following recommendations are suggested as a means of refining record keeping, improving accuracy and making operation of the plant easier.

PHYSICAL IMPROVEMENTS

- Provide necessary chlorine gas piping modifications and additional equipment to allow separate measurement of pre- and post-dosages.

- Provide sample piping and equipment to allow sampling of clearwell influent for chlorine residual analysis.

- Implement a flowmeter calibration program.

- Modify clarifier sludge sampling system to simplify the collection of sludge samples.

- Consider a streaming current monitoring system to optimize coagulant dosages.

- Upgrade flow measuring and recording system to replace existing obsolete equipment.

- Consider a Distributed Programmable Logic Control System to provide automatic process control alarms, operator interface, automatic data collection, storage, display, trending and report generation.

- Consider covering the clarifiers.

- Modify filter inlet/ outlet piping to eliminate flow restrictions.

- Provide continuous chlorine residual and turbidity analysis systems for the plant effluent.

- Rectify problem of deficient post-chlorination contact time.

STUDIES

- Expand the aluminium testing program to determine if pH correction of the raw water is warranted to improve treatment and/ or reduce aluminium residual in the plant effluent.

- Modify filter operating procedures to optimize particulate removal.

- Carry out sieve analyses regularly to determine the extent of media degradation.

WATER PLANT OPTIMIZATION STUDY

UNION WATER SYSTEM WATER TREATMENT PLANT

ONTARIO MINISTRY OF THE ENVIRONMENT

PROJECT NO. 7-2025

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

WATER PLANT OPTIMIZATION STUDY

UNION WATER SYSTEM WATER TREATMENT PLANT

ONTARIO MINISTRY OF THE ENVIRONMENT

PROJECT NO. 7-2025

INTRODUCTION AND TERMS OF REFERENCE

The purpose of the Water Plant Optimization Study (WPOS) is to document and review the present conditions and determine an optimum treatment strategy for contaminant removal at the plant, with emphasis on particulate removal and the disinfection processes.

In striving for excellence in water treatment, it is important to examine all possible approaches, but first, optimum use should be made of the processes already in place.

This optimization study is a beginning and not an end to itself; it is the start of an ongoing documentation of the operation of the plant. It is recommended that this document be updated on an annual basis.

The Ontario Ministry of the Environment has instituted a Drinking Water Surveillance Program (D.W.S.P.) consisting of a continuously updated base of information on Ontario water treatment plants and water quality. In connection with the D.W.S.P., a specific plant investigation and process evaluation study is required for each plant entering the program. The study has been prepared in accordance with a detailed protocol prepared by the Ministry of the Environment.

The Union Water System Water Treatment Plant provides the water supply for the Towns of Essex, Kingsville and Leamington, the Townships of Gosfield North, Gosfield South, Mersea and parts of the Townships of Maidstone and Rochester. In addition, the H. J. Heinz Co. of Canada in Leamington is a system participant and utilizes approximately 30% of the water plant's yearly production.

Serviced populations in the municipalities are as follows:

Essex	6,500
Kingsville	5,500
Leamington	13,000
Gosfield North	2,100
Gosfield South	7,300
Mersea	3,700
Maidstone	1,700
Rochester	840

The optimization study is based on plant operating data from August 1983 to July 1986. It should be noted that all information in the report with respect to equipment, and operating procedures relates to the above period.

SECTION A
RAW WATER

A.1 Source

The source of the water for the Union Water System Water Treatment Plant is Lake Erie. The site is located approximately midway between the Towns of Kingsville and Leamington. The intake structure is approximately 457 m (1,500 ft) offshore, and water is drawn from a depth of 3.4 m (11 ft) below mean water level, approximately 1.5 m (5 ft) above the lake bed.

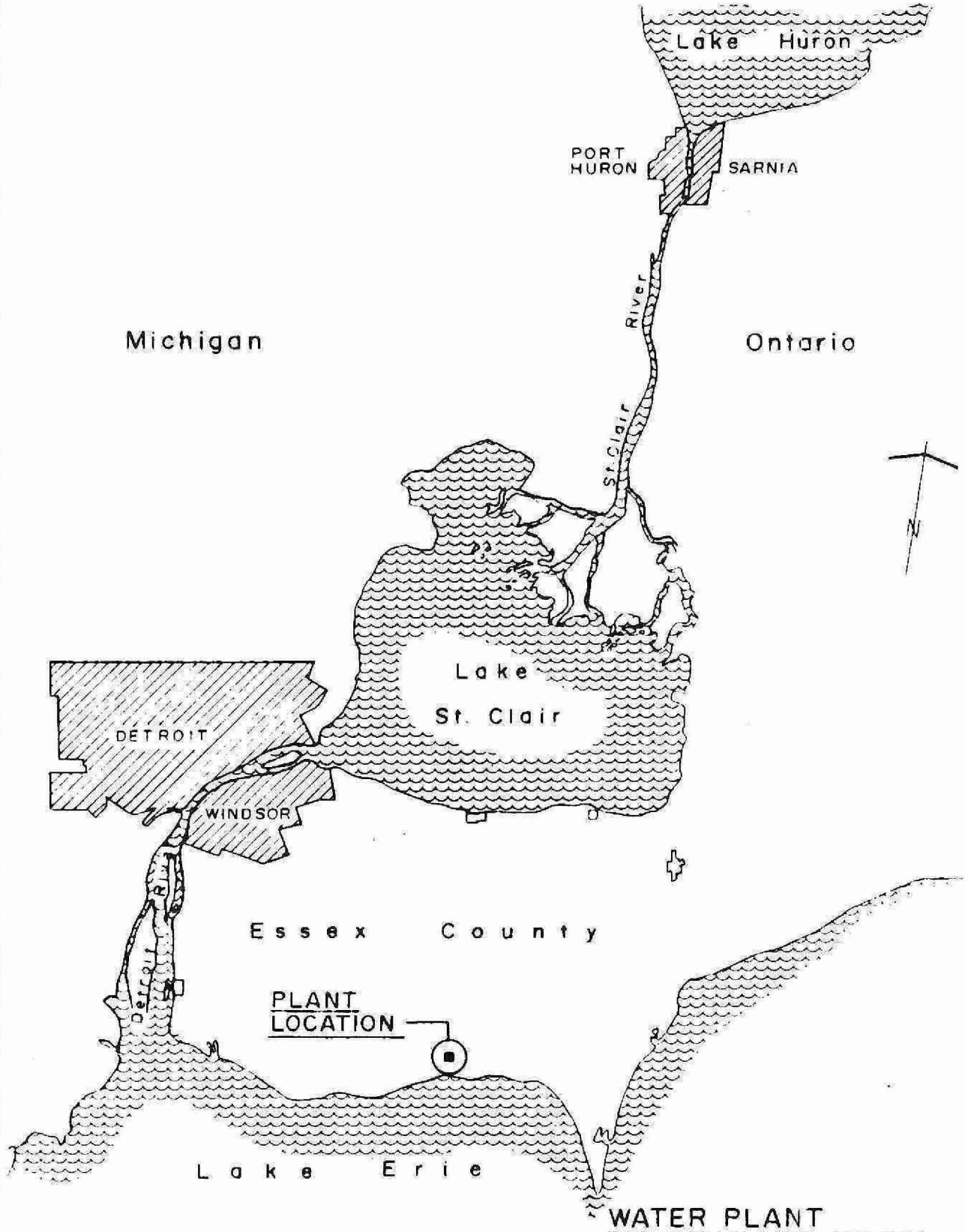
The nearest upstream sanitary sewage treatment works is approximately 8 km (5 mi) west of the intake where seasonal discharge (spring and fall) from the Town of Kingsville oxidation ponds enters the lake.

The location of the plant is shown on Figure No. 1.

A.2 Quality

Throughout the study period, monthly raw water physical and chemical parameters varied as follows:

Parameter	Min.	Max.	Avg.
Turbidity (FTU)	1.2	122	12.5
Colour (Hazen U)	1	15	6.8
pH	7.75	8.4	8.15
Alkalinity	80.0	91.5	88.8
Hardness	98	113	107



WATER PLANT OPTIMIZATION STUDY
OME Project N° 7-2033
UNION WATER SYSTEM
WATER TREATMENT PLANT

LOCATION MAP

0 10 20
SCALE - KILOMETRES

LA FONTAINE, COWIE, BURATTO & ASSOCIATES LIMITED
CONSULTING ENGINEERS

Date 88 03 03
File N° WR158 U
Figure N° 1

SECTION B
FLOW MEASUREMENT

B.1 Raw Water Flow Measurement

Raw water flow is measured at the water treatment plant building by two venturi tubes installed in the two 450 mm (18 in) diameter raw water pipes upstream of the microstrainer inlets. The high and low pressure taps from each tube are connected to a pneumatic differential pressure transmitter which has its output signal connected to a square root extractor. The pneumatic outputs of the two square root extractors are input to a common pneumatic totalizer which has its output signal connected to a pressure/current converter. The output of the converter is fed to an electronic counter which indicates the total raw water flow.

In addition to the above, the instrumentation system has strip chart recorders recording flow through the individual pipelines and total flow. Plant staff indicate the system is only adjusted when an obvious discrepancy is noted between the recorded flow and the capacity of the raw water pumps. The flow measuring and recording system is not calibrated on a regular basis.

Because of the number of instruments in the flow measuring system and the lack of regular calibration, the raw water flow records could be subject to considerable error. This could explain why the raw water flows are less than the treated water flows the majority of the time. (see Table 1.1 in Appendix C)

B.2 Treated Water Flow Measurement

Treated water flow is measured by a Sparling 200 mm x 760 mm (8 in x 30 in) compound meter in the plant effluent pipeline. Flow records are taken from a remote counter on the plant's master control panel. The remote reading is checked frequently against the reading on the register on the meter and the two readings have been found to agree. The treated water flow measuring system is not calibrated on a regular basis.

B.3 Filter Backwash Water Flow Measurement

Main backwash water flow is measured by a 300 mm (12 in) diameter venturi tube installed in the discharge piping of the backwash water pump. A pneumatic system similar to that for raw water flow indicates and totalizes main washwater flow on the filter control console. In addition, a manual loading station on the filter control console allows the operator to manually adjust the backwash water flow rate.

The flow to the filter surface agitators is measured by a 150 mm (6 in) diameter venturi tube having a pneumatic instrumentation system similar to the raw water system.

B.4 Filtered Water Flow Measurement

Flow through each filter is measured by a 300 mm (12 in) diameter venturi tube using a pneumatic system similar to the raw water flow measuring system.

B.5 Validity of Flow Measurement

a) Venturi/Pneumatic Systems

The venturi/pneumatic flow measuring systems have been in operation for approximately 30 years and it is difficult in some cases to obtain replacement parts for some of the instruments. Plant staff has not indicated any other major problems with the flow measuring systems but because the parts and instrumentation systems are worn and because of the number of instruments involved in each measuring system, as indicated in Section B.1 - Raw Water Flow Measurement, the accuracy of the measuring systems could probably be improved by replacing the outdated equipment with new modern equipment.

SECTION C
PROCESS COMPONENTS

C.1 General

The plant components include the intake, coarse and fine raw water screens, low lift pumps, microstrainers, solids contact upflow clarifiers, filters, underground storage, high lift pumps and chemical facilities for coagulation, disinfection and taste and odour control (Figure 2).

Treatment flow rates are selected manually and the high lift pumps are operated to maintain the water level in the elevated storage tank.

Refer to Appendix "A" for:

Figure 3 - Site Plan
Figure 4 - Block Schematic
Figure 5 - Process Flow Diagram (3 sheets)

C.2 Design Data

a) Plant Capacity

The plant, as originally constructed in 1960, had a design capacity of 36.43 ML/d (8 mgd). In subsequent years, an additional clarifier and microstrainer were added (1970) and additional pumping capacity installed. In 1973 the top 280 mm (11 in) of filter sand (1/2 the depth) was removed and replaced with anthracite to allow operation at a higher rate. It was hoped the capacity could be doubled to 72.6 ML/d (16 mgd). However, the filter inlet works were designed for the original plant capacity of 36.43 ML/d (8 mgd) and at flows greater than 68.2 ML/d (15 mgd), hydraulic phenomena occur at the filter inlet channels which restrict the flow causing discharge through the overflows. This problem has been studied and a solution proposed that would allow operation of the filters at 72.6 ML/d (16 mgd). However, because the corrective work requires shutting down all the filters, it will not be undertaken until proposed additional filters have been constructed. At the present time then, the plant should be rated at 68.2 ML/d (15 mgd).

UNION WATER SYSTEM WATER TREATMENT PLANT

BLOCK DIAGRAM

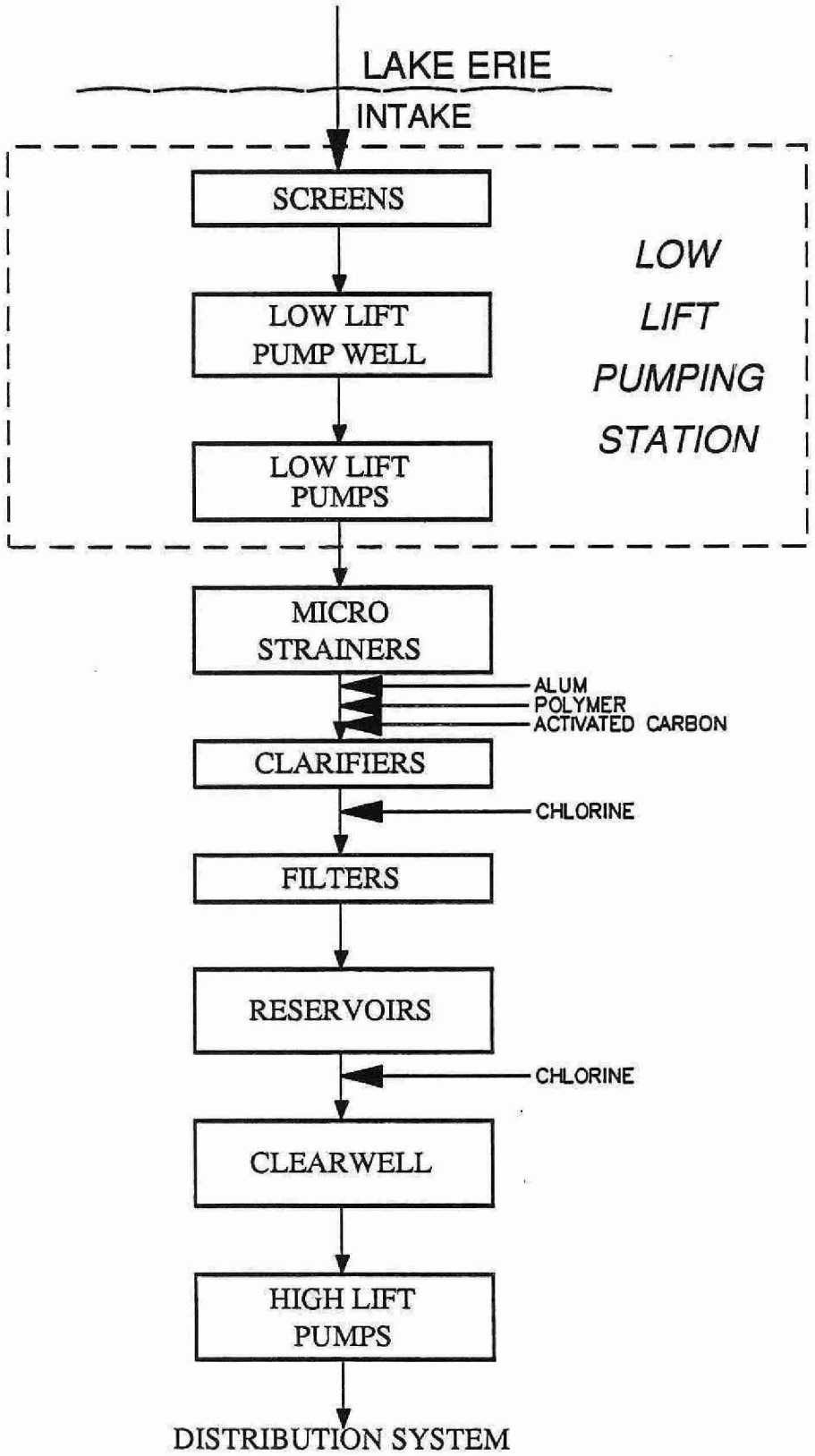


Figure 2.

C.3 Process Component Inventory

a) Intake System

Crib

- One 4.9 m x 4.9 m (16 ft x 16 ft) rock-filled timber crib with a 3.0 m (10 ft) diameter by 1.37 m (4.5 ft) diameter steel bellmouth 90 degree elbow.

- Inlet port elevation 170.7 m (560.1 ft), approximately 1.5 m (5 ft) above the lake bed.

Intake Pipe

- 457 m (1,500 ft) long 1350 mm (54 in) diameter corrugated steel intake pipe installed approximately 1.5 m (5 ft) below the lake bed.

- Capacity 218 ML/d at mean lake surface elevation of 174.1 m (571.2 ft).

b) Screening

- The entry chamber of the Low Lift Pumping Station has a "U"-shaped fixed coarse bar screen having an effective length of approximately 4.4 m (14.5 ft). The screen is approximately 5 m (16.4 ft) high and is constructed of 40 mm x 9.5 mm (1.5 in x 0.375 in) thick flat bars at 75 mm (3 in) centers.

- The Low Lift Pumping Station has two travelling water screens 1.8 m (5.9 ft) wide by 5 m (16.4 ft) high. The screens have 9.5 mm (0.375 in) mesh.

c) Low Lift Pumping

- Pump Suction Well is 14.4 m x 5.9 m x 4.67 m (47.25 ft x 19.33 ft x 15.33 ft) deep. Volume is approximately 300m^3 (66,000 gal) at normal water levels.

- Five Vertical turbine pumps with the following nominal design operating points:

  No. 1 - 27.5 ML/d (4,200 gpm) @ 33.5 m (110 ft)
  - 149 kW (200 HP) elec.

  No. 2 - 19.6 ML/d (3,000 gpm) @ 32 m (105 ft)
  - 93 kW (125 HP) elec. diesel

  No. 3 - 19.6 ML/d (3,000 gpm) @ 32 m (105 ft)
  - 93 kW (125 HP) elec.

  No. 4 - 9.8 ML/d (1,500 gpm) @ 30.5 m (100 ft)
  - 45 kW (60 HP) elec.

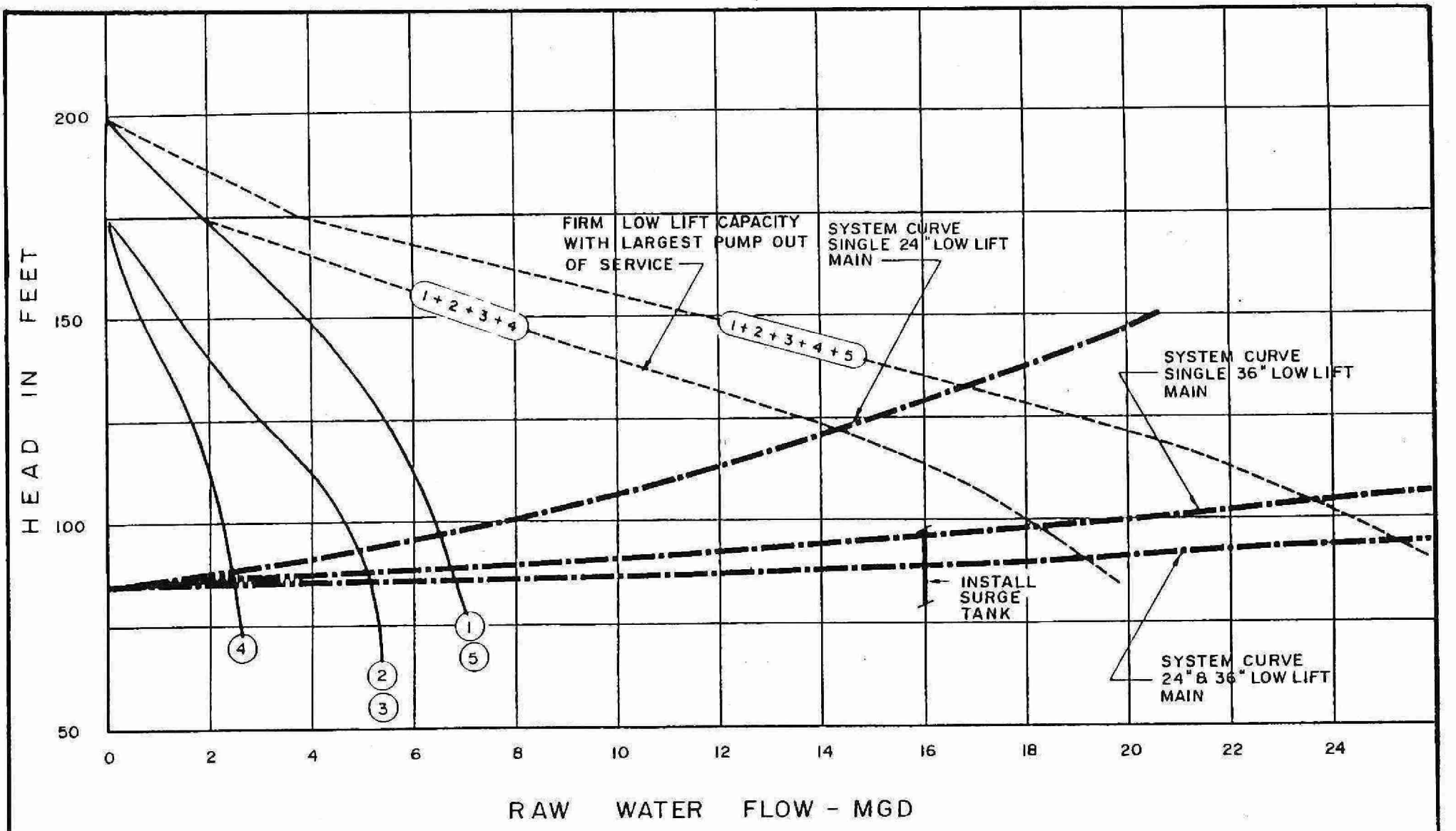
  No. 5 - 27.5 ML/d (4,200 gpm) @ 33.5 m (110 ft)
  - 187 kW (250 HP) elec.

- Total Capacity 113 ML/d* (24.9 mgd)
- Firm Capacity 86.4 ML/d* (19 mgd)
- Standby Capacity 19.6 ML/d (4.3 mgd)
- Two Low Lift Pump discharge mains
  - 600 mm (24 in) diameter 890 m (2,920 ft) long
  - 900 mm (36 in) diameter 1,100 m (3,609 ft) long

* Refer to pump curve in Figure 6. The firm capacity is derived from the curves.

d) Microstrainers

- Two Glenfield-Kennedy 3 m (10 ft) diameter x 3 m (10 ft) long microstrainers with MK-1 stainless steel 35 micron fabric, capacity 36.3 ML/d (8 mgd) each.



④ — 1500 IGPM @ 100' (60 H.P.)

②&③ — 3000 IGPM @ 105' (125 H.P.)

①&⑤ — 4200 IGPM @ 110' (200 & 250 H.P.)

PRESENT LOW LIFT SYSTEM

UNION WATER PLANT

Figure 6

e) Clarification

- Two outdoor clarifiers are in place.

- One Graver 28.65 m (94 ft) diameter x 5.64 m (18.5 ft) SWD solids contact clarifier with surface collection launders, capacity 36.3 ML/d (8 mgd).

- One Eimco 28.65 m (94 ft) diameter x 5.64 m (18.5 ft) SWD solids contact clarifier with submerged collection pipes, capacity 36.3 ML/d (8 mgd).

- Overflow rates:

  - 2.35 m/h (0.8 gpm/sq ft) based on total tank area
  - 2.72 m/h (0.93 gpm/sq ft) based on surface area of settling zone (Clarifier No. 1)
  - 2.63 m/h (0.9 gpm/sq ft) based on surface area of settling zone (Clarifier No. 2)

- Volume of each clarifier 3,950 m^3 (870,000 gal), retention time 157 minutes at 36.3 ML/d (8 mgd).

- Sludge disposal is through plant storm sewer system to Lake Erie.

f) Filtration

- Four double filters each 5.5 m (18 ft) x 11.0 m (36 ft), one-half of each filter backwashed separately.
- Palmer surface agitators in all filters (8 per filter).
- Filter media:

  Miller block underdrains
  380 mm (15 in) depth of graded gravel
  280 mm (11 in) depth of silica sand, E.S.= 0.55, U.C.= 1.59
  280 mm (11 in) depth of anthracite, E.S.= 0.90, U.C.= 1.65

- Depth of water above filter media - 2 m (6.5 ft)
- Influent turbidity range (FTU): 0.15 - 6.76 (extremes)
- Effluent turbidity range (FTU): 0.05 - 0.82 (extremes)
- Length of run: 60 hr. (average)
- Headloss:
  clean bed: 0.30 - 0.64 m (1 - 2 ft) depending on flow
  dirty bed: 2.13 m (7 ft) maximum
- Filtering flow rate: 3.2 - 12.8 m/h (1.1 - 4.4 gpm/sq ft)
- Backwash flow rate: 32 m/h (11 gpm/sq ft)
- Water filtered/cycle: 430 m^3/m^2 (8,800 gal) average
- Backwash water use: 3.9 m^3/m^2/wash (80 gal/wash)
- Retention time: 13.5 min. at 12 m/h (4 gpm/sq ft)
- Capacity: 68.2 ML/d (15 mgd) at 12 m/h (4 gpm/sq ft)

g) Underground Storage

- One 9,090 m^3 (2 mil gal) underground concrete reservoir.
- One 13,636 m^3 (3 mil gal) underground concrete reservoir.

h) High Lift Pumping

- Pump suction well (clearwell)
  21.5 m (70.5 ft) x 4.5 m (14.75 ft) x 5 m (16.5 ft) deep concrete well
- Volume 480 m^3 (105,000 gal)
- Retention time 9.5 minutes @ 72.6 ML/d (16 mgd)
- High lift pumps (horizontal split case) with the following nominal design operating points:
  No. 6 - 17.7 ML/d (3.9 mgd) @ 61 m (200 ft)
  - 149 kW (200 HP) elec.
  No. 7 - 17.7 ML/d (3.9 mgd) @ 61 m (200 ft)
  - 149 kW (200 HP) elec.
  No. 8 - 23.6 ML/d (5.2 mgd) @ 61 m (200 ft)
  - 224 kW (300 HP) elec./diesel

No. 9 - 47.1 ML/d (10.4 mgd) @ 61 m (200 ft)
- 373 kW (500 HP) elec.

No. 10 - 5.2 ML/d (1.1 mgd) @ 61 m (200 ft)
- 56 kW (75 HP) elec.

No. 12 - 12.3 ML/d (2.7 mgd) @ 64 m (210 ft)
- 112 kW (150 HP) elec.

No. 14 - 13.1 ML/d (2.9 mgd) diesel engine-driven

- Total capacity in excess of 109 ML/d (24 mgd)*
- Firm capacity 96 ML/d (21 mgd)*
- Standby capacity 36.7 ML/d (8.1 mgd)

* Refer to pump curve in Figure 7. The firm capacity is derived from the curves however the curve for pump no. 14 is not shown and it is estimated it would contribute 10 ML/d (2.2 mgd).

i) Backwash Waste Water Treatment

Filter backwash wastewater and clarifier sludge is discharged by gravity without treatment to Lake Erie.

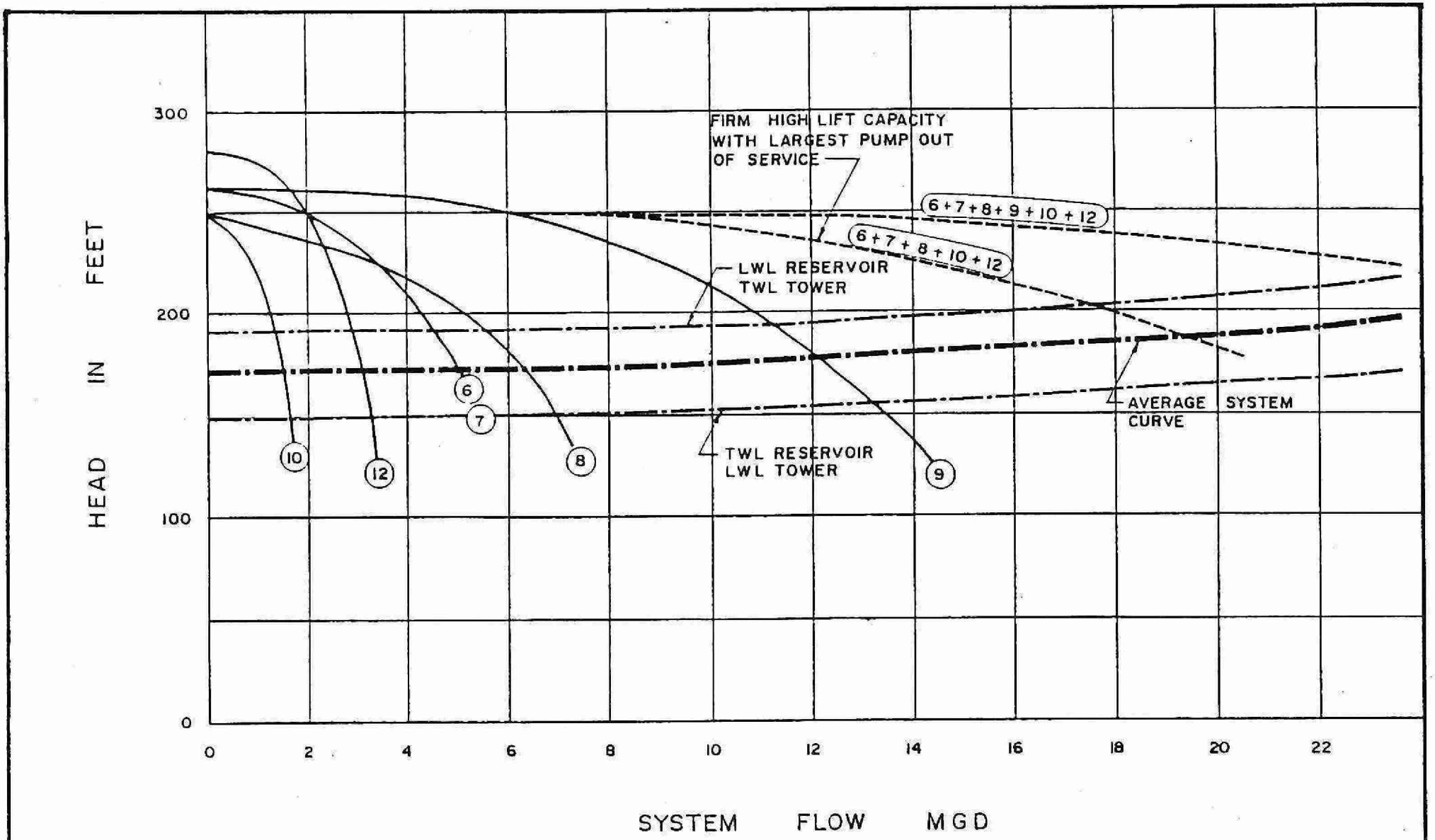
C.4 Chemical Systems

a) Disinfection

- Chlorine is stored as a liquid in ten 0.9 tonne (1 ton) containers under 80 psig and is withdrawn as a gas. One empty container is maintained for emergency storage purposes.

- Application points
  pre: clarifier effluent (clarifier influent prior to 1985 05 07)
  post: clearwell inlet

- Two scales are used. Chlorine for pre- and post-chlorination is withdrawn from the containers on one scale while the containers on the other scale are on standby.



(6) 2700 IGPM @ 200' (200 H.P.)
(7) 2700 IGPM @ 200' (200 H.P.)
(8) 3600 IGPM @ 200' (300 H.P.)
(9) 7200 IGPM @ 200' (500 H.P.)
(10) 800 IGPM @ 200' (75 H.P.)
(12) 1875 IGPM @ 210' 150 H.P.
(14) 2000 IGPM (DIESEL DRIVE)

PRESENT HIGH LIFT SYSTEM

UNION WATER PLANT

Figure 7

- Chlorinators

  pre: Wallace & Tiernan Model A711 gas chlorinator, 907 kg/d (2,000 lb/d) maximum capacity, 0-13 kg/d (0-250 lb/d) rotameter.

  post: Wallace & Tiernan Model A711 gas chlorinator, 907 kg/d (2,000 lb/d) maximum capacity, 0-68 kg/d (0-150 lb/d) rotameter.

  standby: Wallace & Tiernan Model A711 gas chlorinator, 907 kg/d (2,000 lb/d) maximum capacity, 0-113 kg/d (0-250 lb/d) rotameter.

- The chlorine solution derived from the pre-chlorinator is proportioned through two rotameters and fed to each of the two clarifiers.

b) Coagulant

- Liquid alum stored in two 22.7 m^3 (5,000 gal) P.V.C. lined concrete tanks.

- Two Wallace & Tiernan Model 44-225 dual-head diaphragm metering pumps with calibration chambers, maximum capacity 13 L/min (172 gal/hr). Maximum dosage is 167 mg/L at 72.6 ML/d (16 mgd). One backup pump is available.

- Application point: clarifier influent.

c) Coagulant Aid and Filter Aid

(i) Coagulant Aid

- Alchem 8171-SC non-ionic polymer stored in drums.

- Two 2.27 m^3 (500 gal) mixing/day tanks.

- One Wallace & Tiernan Model 44-125 dual-head diaphragm chemical metering pump with calibration chambers, maximum capacity 13 L/min. Maximum dosage is 0.25 mg/L at 72.6 ML/d (16 mgd).
- Application point: clarifier influent

(ii) Filter Aid

- Alchem 8103 is applied to water leaving the clarifiers when turbidity going onto the filters is high.

- The equipment is similar to that used for coagulant aid and incorporates a Wallace & Tiernan Model 44-216 diaphragm chemical metering pump.

d) Taste and Odour Control

- Powdered activated carbon (Hydrodarco B) stored in 22 kg (50 lb) bags.

- One bucket elevator, two 0.25 m^3 (9 cu ft) storage hoppers.

- Two Wallace & Tiernan volumetric screw feeders with a maximum capacity of 0.95 m^3/d (33 cu ft/d) each and mixing tanks.

- Two centrifugal feed pumps.

- Maximum dosage rate 15 mg/L at 72.6 ML/d (16 mgd).

C.5 Sampling

The following is a description of the tests carried out by plant staff. Unless otherwise indicated, test samples are taken from display jars located adjacent to the laboratory. Table 9 gives information regarding the sample pumping systems. The sample flow rate was determined from a time-displacement test carried out at the display jars. Table 10 gives a summary of the tests performed at the plant.

TABLE 9
SAMPLING SYSTEMS

SOURCE	LENGTH/DIA *m/mm*	FLOW *L/min.*	VELOCITY *m/s*	SAMPLE TRAVEL TIME *min.*	
Raw Water	58/20	1.9	0.10	9.7	
(one sample pipe)	11/12	1.9	0.28	0.7	10.4 min total
Clarifier Effluent #1	28/12	1.9	0.28	1.67	
Clarifier Effluent #2	16/20	1.9	0.10	2.7	
(one sample pipe)	11/12	1.9	0.28	0.7	3.4 min total
Filter Effluent	43/12	1.9	0.28	2.6	
Plant Effluent	23/12	1.9	0.28	1.4	

TABLE 10
PLANT TESTING SUMMARY

TEST	CHEMICAL APPLICATION POINT	SAMPLING POINT	CONTACT TIME	TESTING FREQUENCY	REPORTING FREQUENCY	TESTING INSTRUMENT
Pre-chlorine Residual	Clarifier Effluent	Combined Filter Effluent	18 min. at 72.6 ML/d	2 hours	2 hours	Hach dr/2 Spectrophotometer DPD Method
Post-chlorine Residual	Clearwell Inlet	Plant Discharge Header	9.5 min. at 72.6 ML/d	2 hours	2 hours	Hach dr/2 Spectrophotometer DPD Method
Raw Water Turbidity	N/A	Micro-Strainer Inlet Piping	N/A	Continuous	Hourly	Flow through cell in Hach Model 18900 Ratio Turbidimeter
Clarifier Effluent Turbidity	N/A	Filter Inlet Piping	N/A	2 hours	2 hours	Hach Model 18900 Ratio Turbidimeter
Filter Effluent Turbidity (Individual)	N/A	Filter Effluent Piping at Each Filter	N/A	Continuous	Hourly	Hach Model 1720B Turbidimeter located at sampling location Remote indication at laboratory
Filter Effluent Turbidity (Combined)	N/A	Filter Effluent Header Pipe	N/A	Continuous	Hourly	Hach Model 1720B Turbidimeter located at sampling location Remote indication at laboratory
Plant Effluent Turbidity	N/A	High Lift Pump Discharge Header	N/A	Continuous	Hourly	Hach Model 1720B Turbidimeter and indication at laboratory
Clarifier Effluent Aluminum	N/A	Clarifier Effluent	N/A	Weekly	Weekly	Hach Model dr/2 Spectrophotometer
Plant Effluent Aluminum	N/A	High Lift Pump Discharge Header	N/A	Weekly	Weekly	Hach Model dr/2 Spectrophotometer
Raw Water pH	N/A	Micro-Strainer Inlet Piping	N/A	Daily	Daily	Orion Research Model 231 pH meter
Plant Effluent pH	N/A	High Lift Pump Discharge Header	N/A	Daily	Daily	Orion Research Model 231 pH meter

With respect to turbidity measurements, the Hach Model 18900 Ratio Turbidimeter is calibrated once per month using primary standards. The Hach Model 1720B Turbidimeters are calibrated to the Ratio Turbidimeter once per week.

C.6 Process Automation

The plant had instrumentation and control systems that allowed completely automatic operation of the plant. However, because the plant operates at maximum capacity during the summer some of the automatic control systems are a detriment to operation of the plant. For example, automatic initiation of filter backwashing is not appropriate during peak periods.

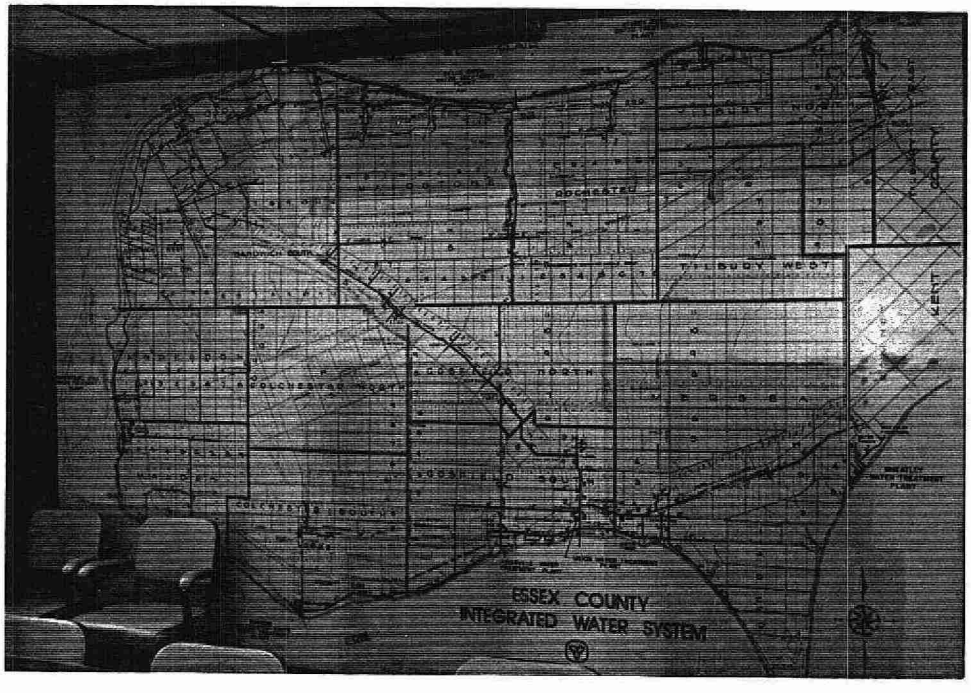
The plant management prefers to have more operator involvement in the operation of the plant and has a rigorous operating and reporting system.

The master control panel has indications of the operational status of all equipment and has level and flow indicators and recorders for the plant processes. Most of the equipment can be operated from the master control panel.

C.7 Photographs

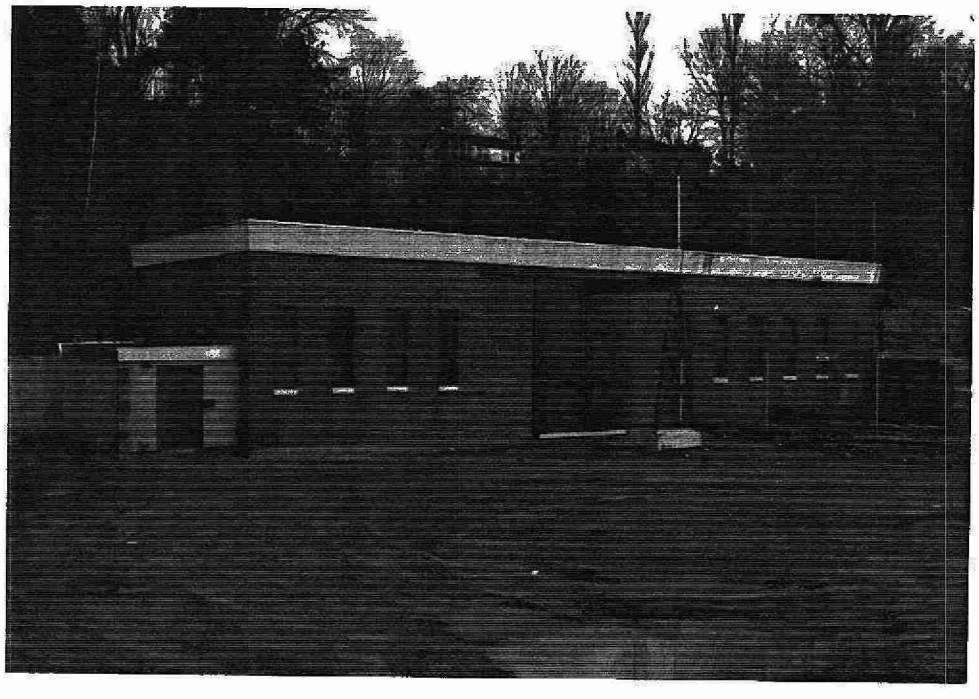
Following are photographs of the plant and its components.

1. Plant Plaque

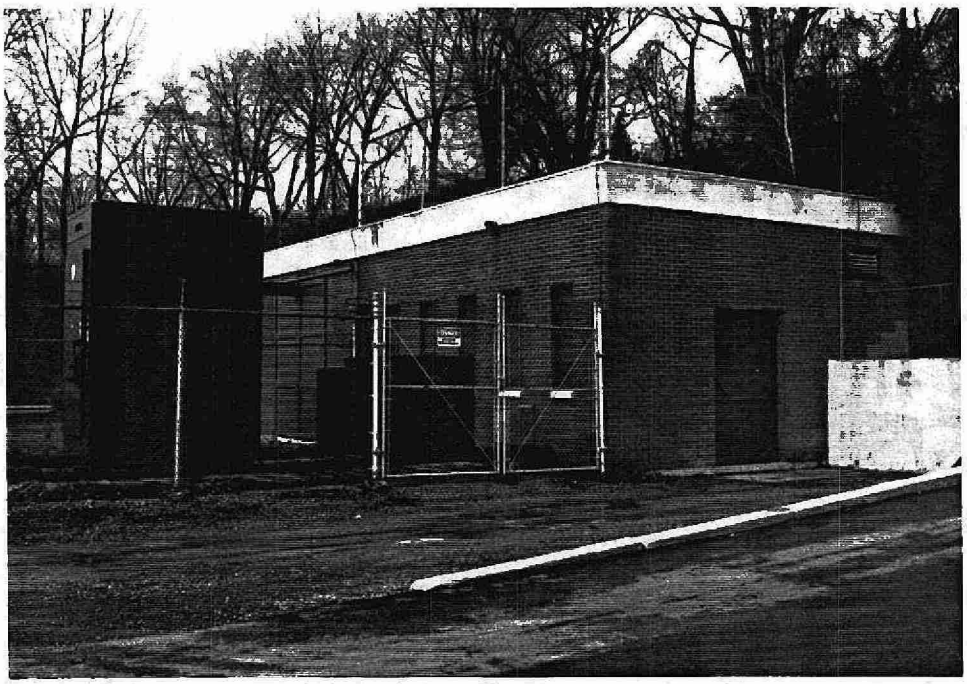


2. Map of Service Area

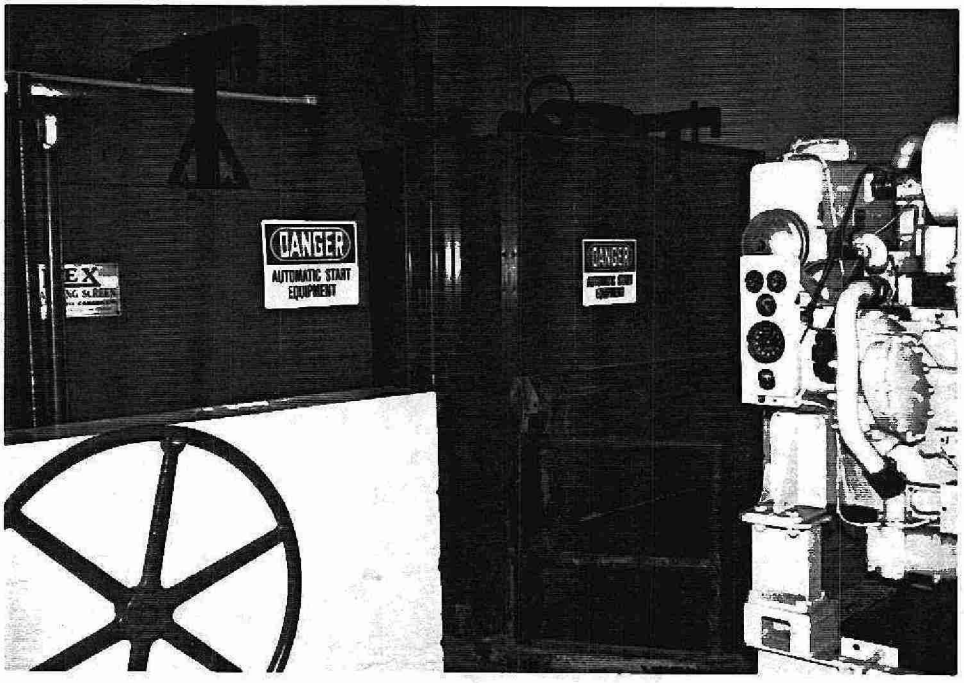
3. Lake Erie Shoreline at Low Lift Pumping Station Site



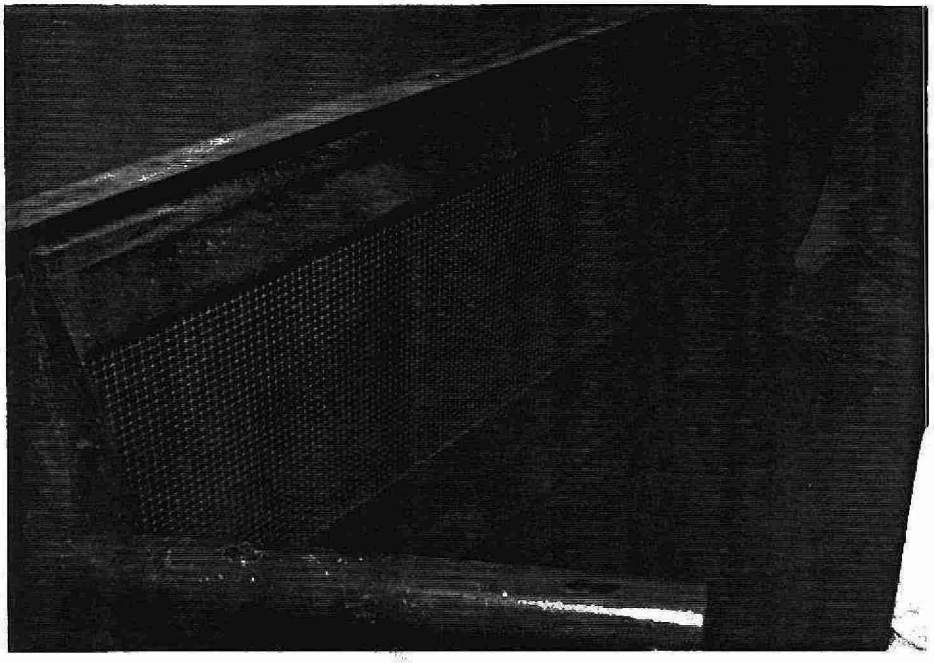
4. South and West Elevations of Low Lift Pumping Station



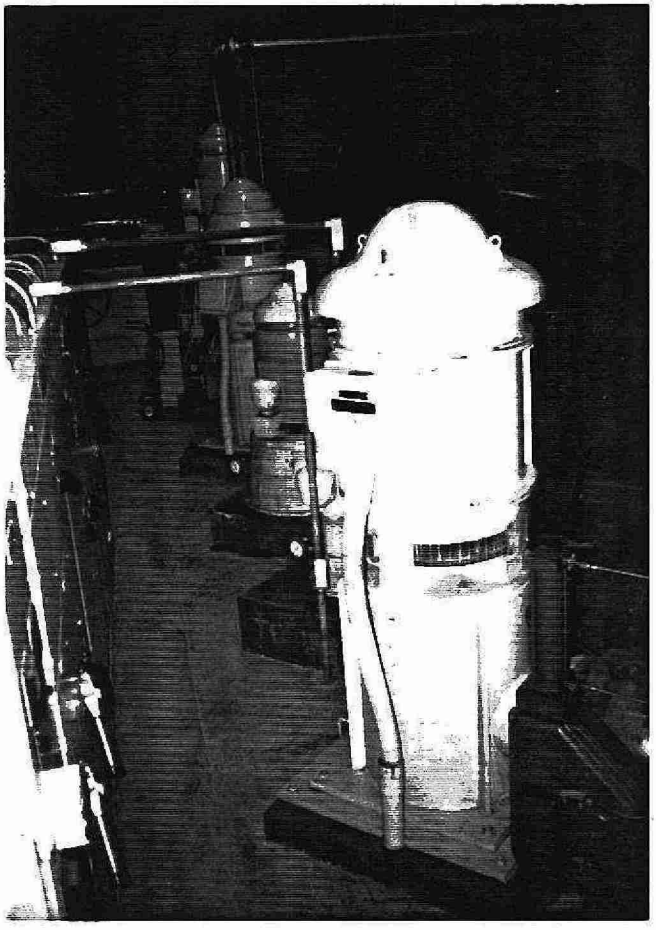
5. South and East Elevations of Low Lift Pumping Station



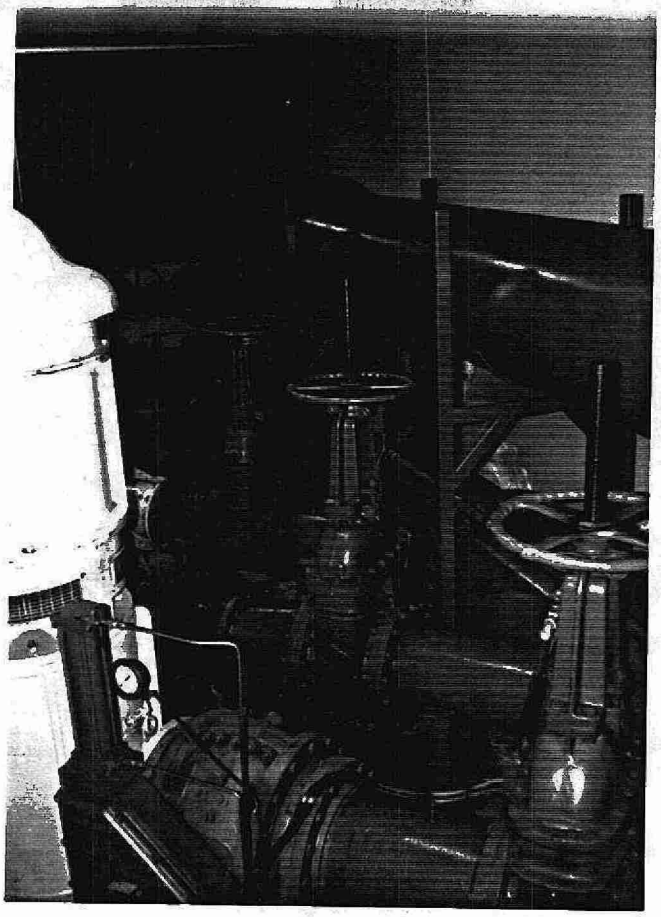
6. Travelling Water Screens



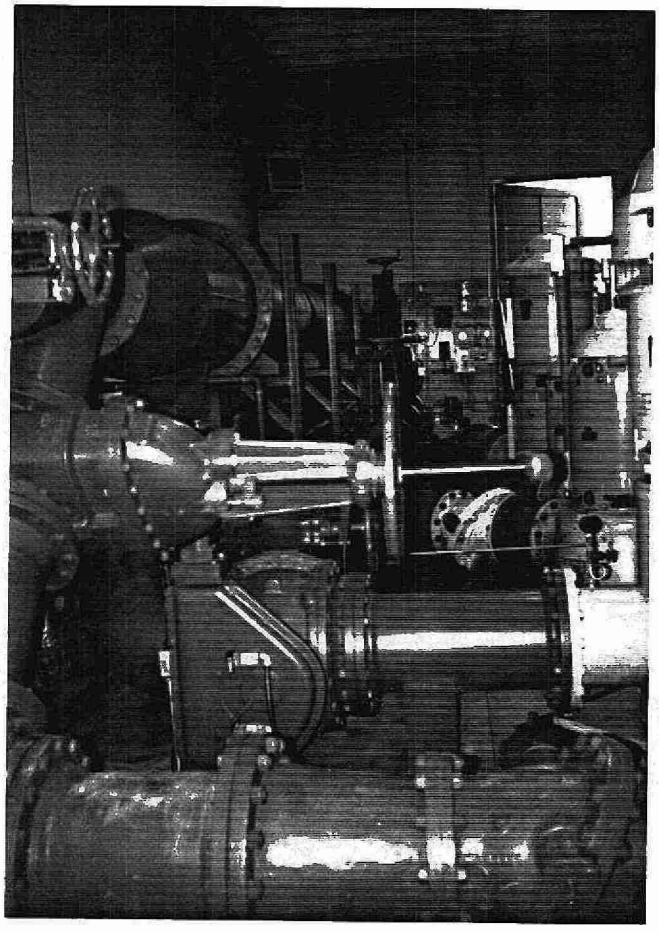
7. Close Up of Travelling Water Screen Basket



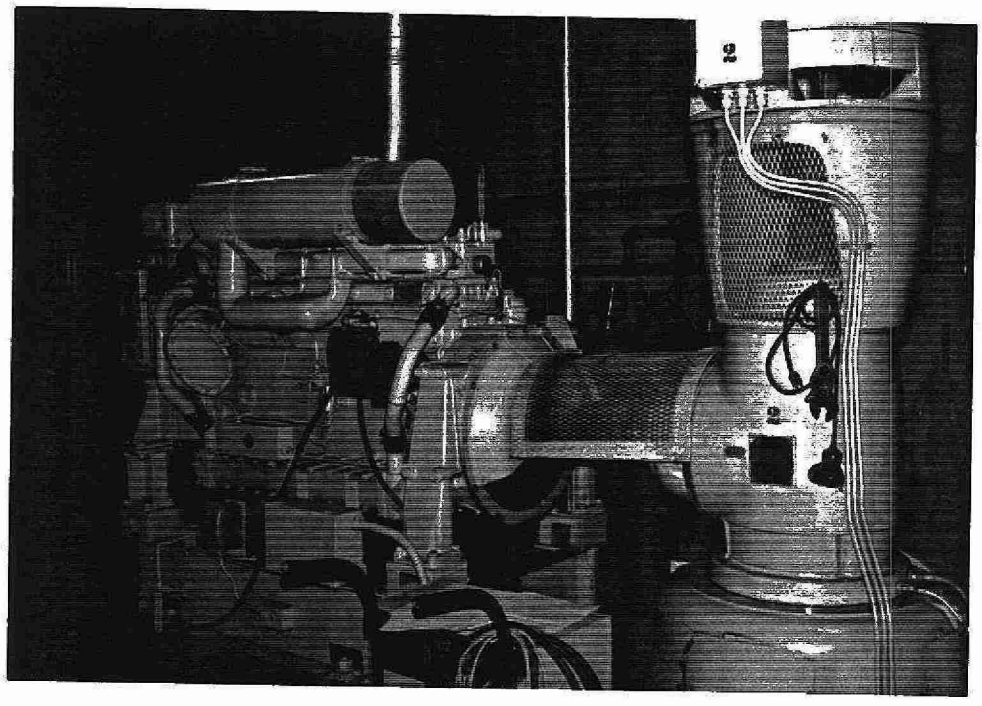
8. View of Low Lift Pumps and Motors



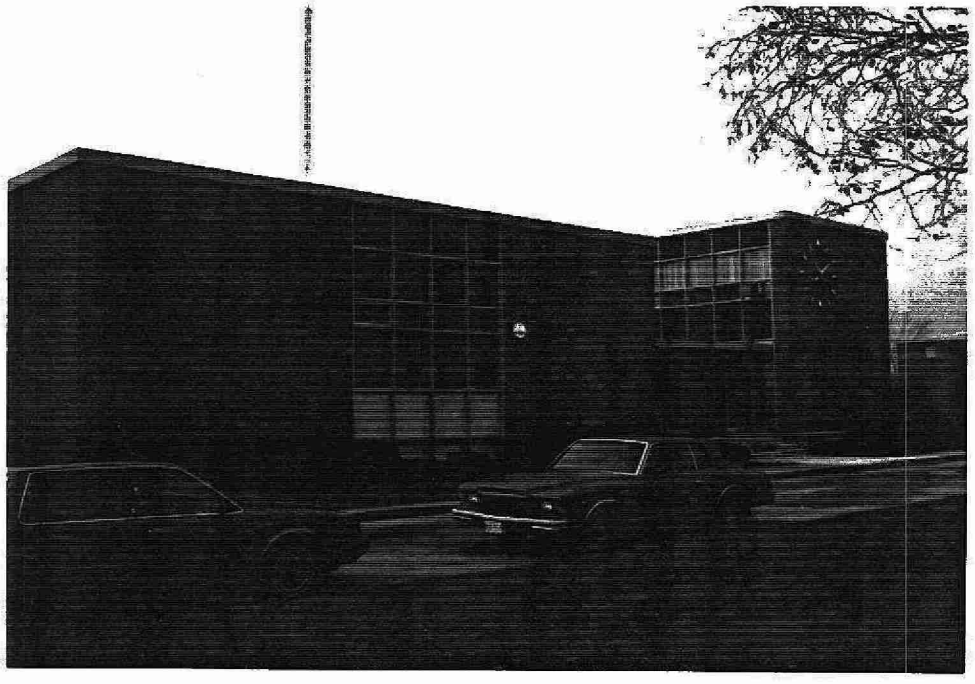
9. Low Lift Pump Discharge Piping Valves and Headers



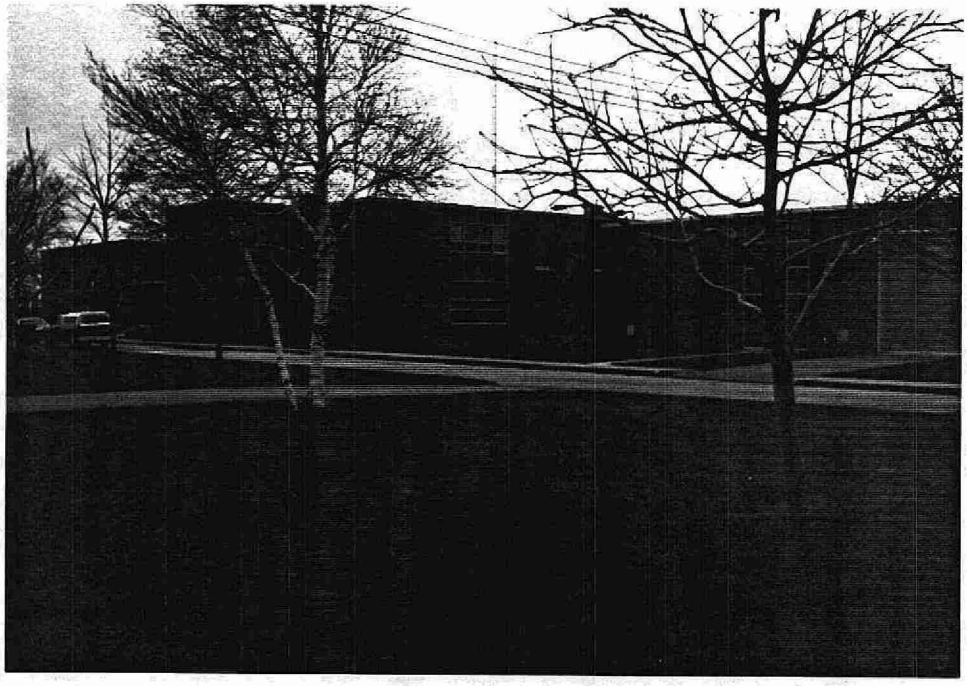
10. Low Lift Pumps and Piping



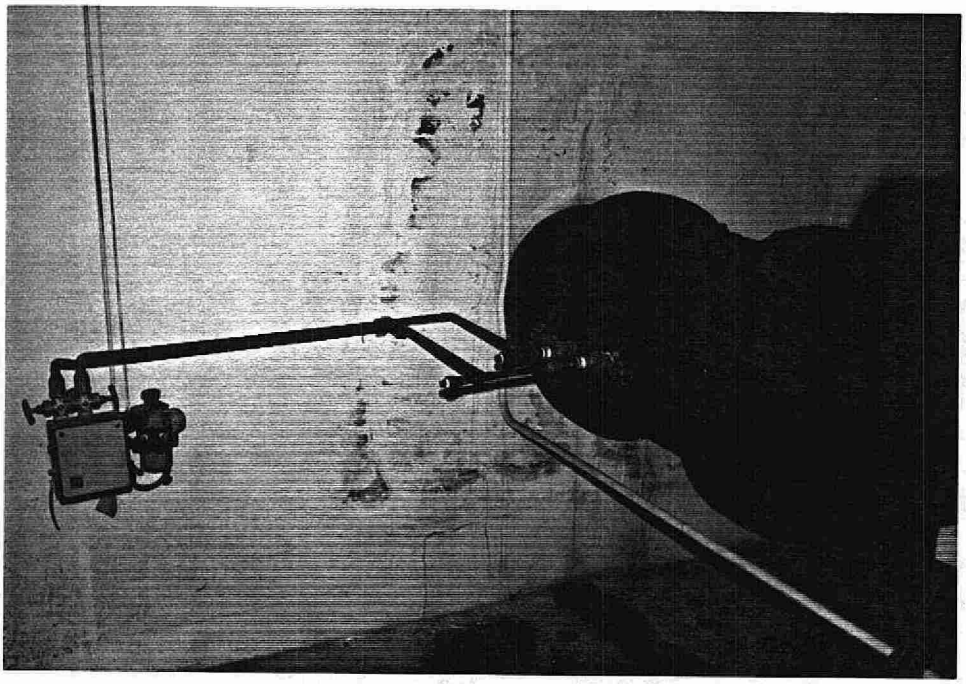
11. Low Lift Pump No. 2 - Diesel Engine Drive



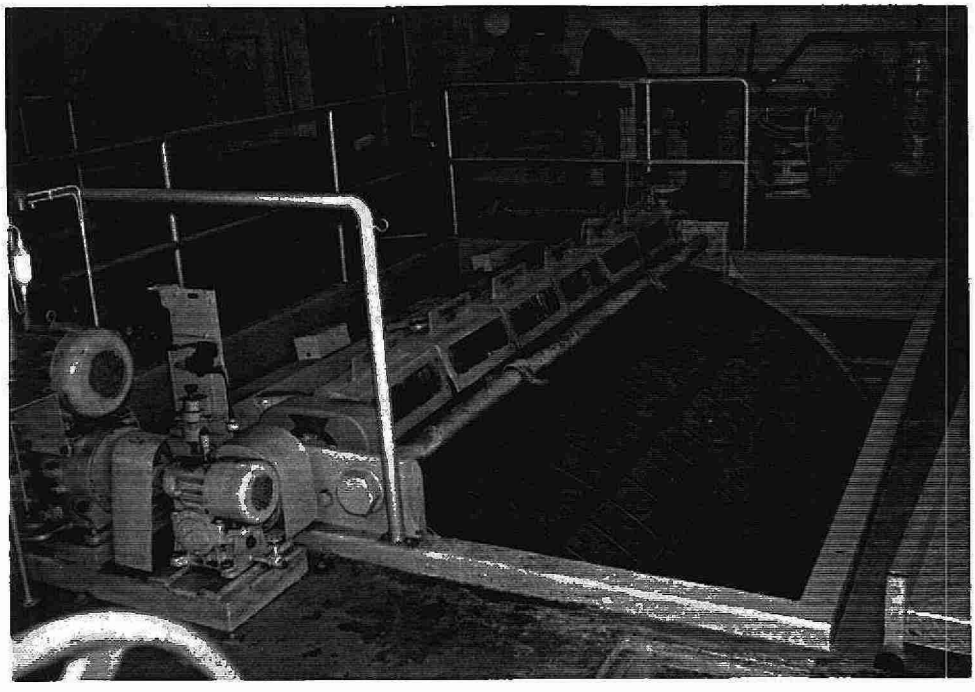
12. View of Treatment Plant Building from the Southeast



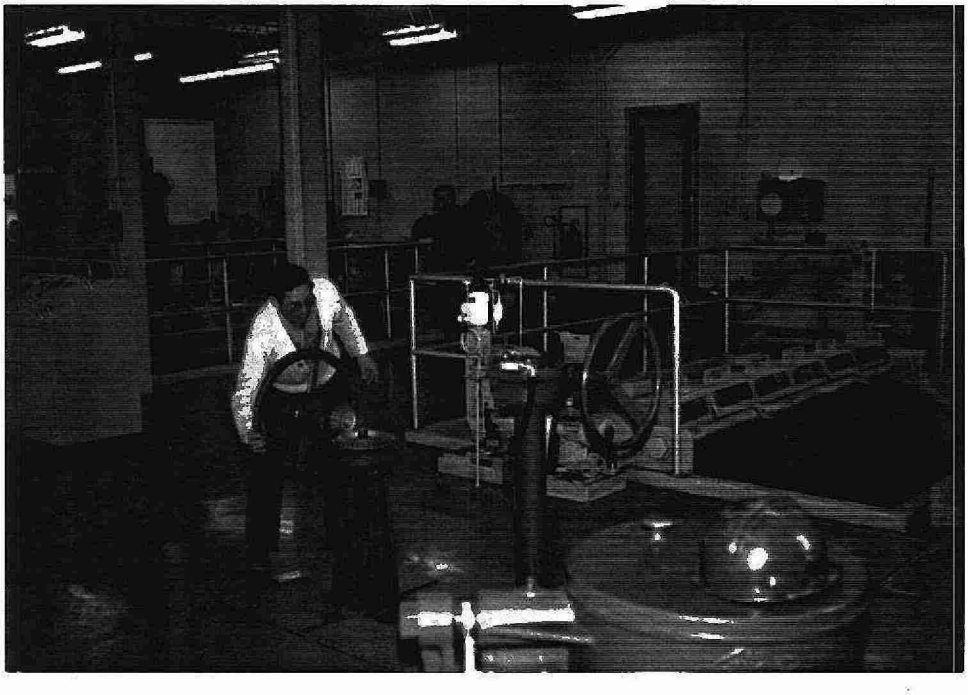
13. View of Water Treatment Plant Building and Chlorine Building from the Northeast



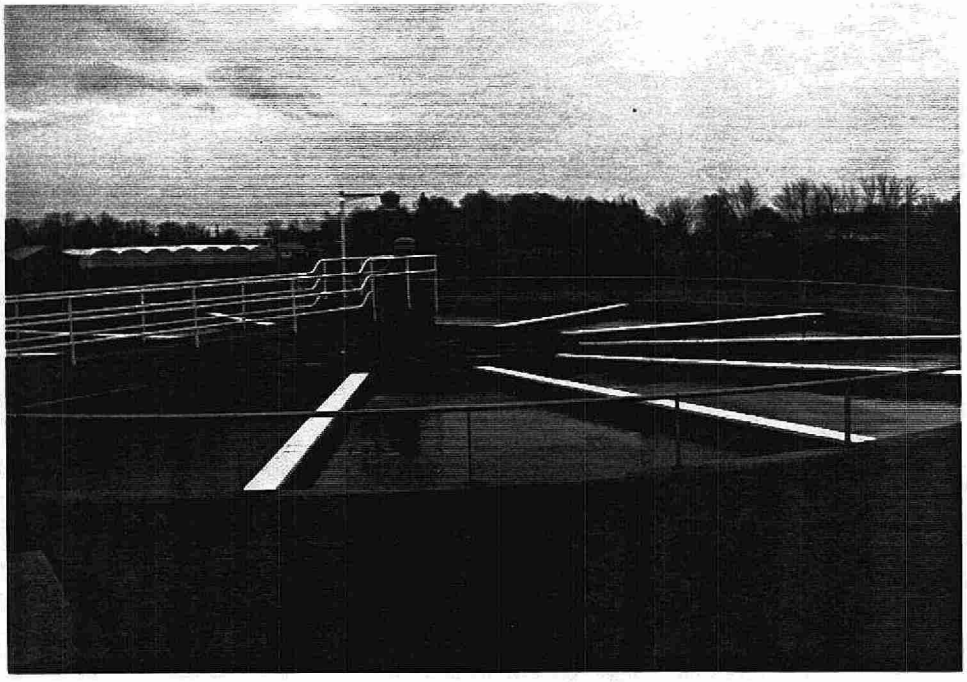
14. Raw Water Flow Measuring System - Venturi Tube and Differential Pressure Transmitter



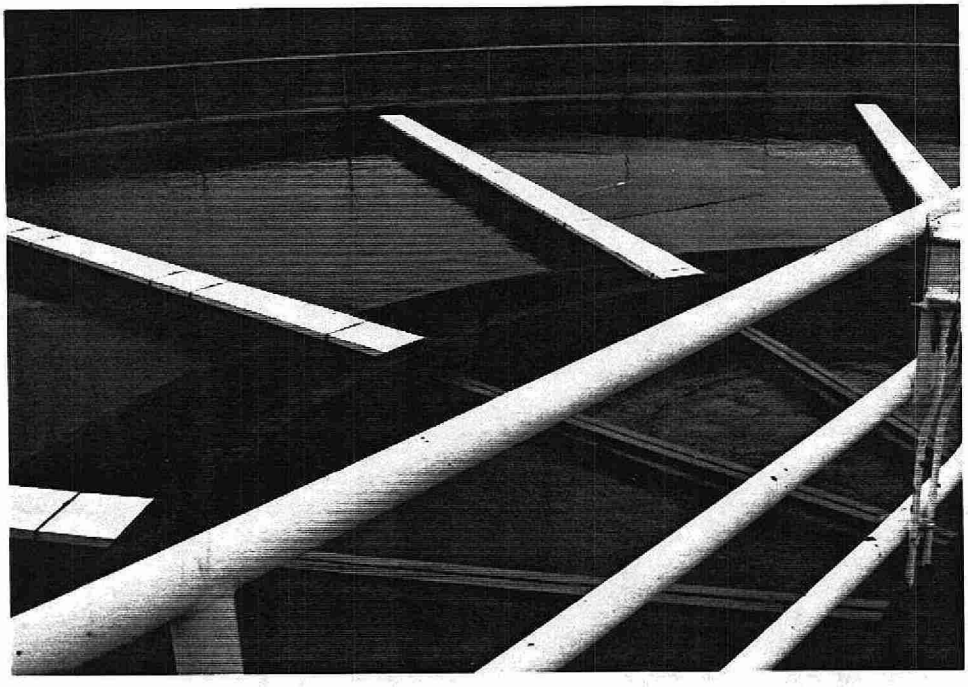
15. View of Microstrainer



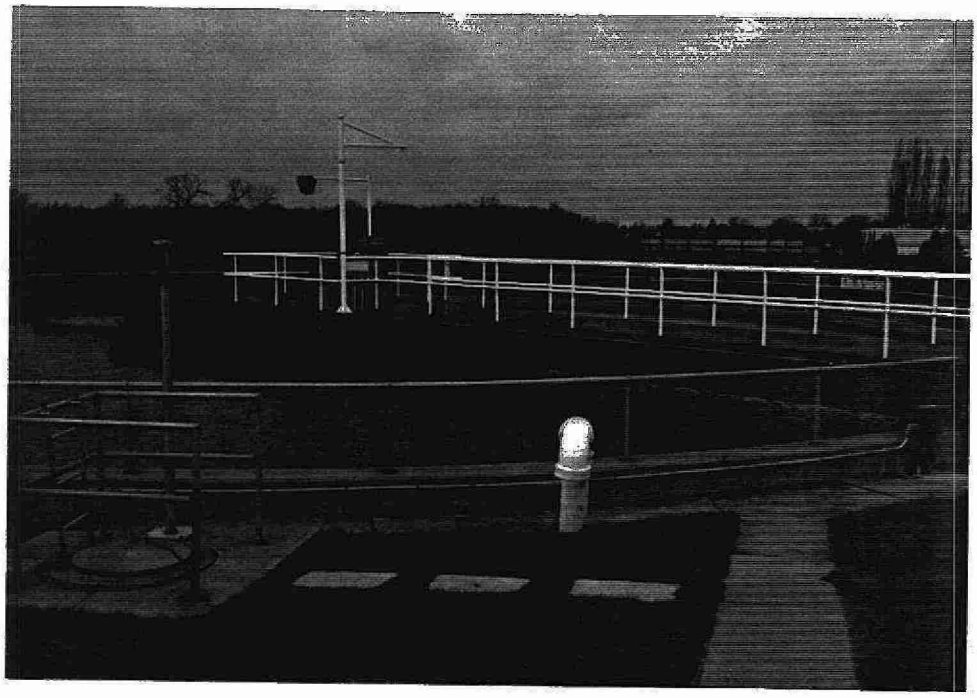
16. Microstrainer Room



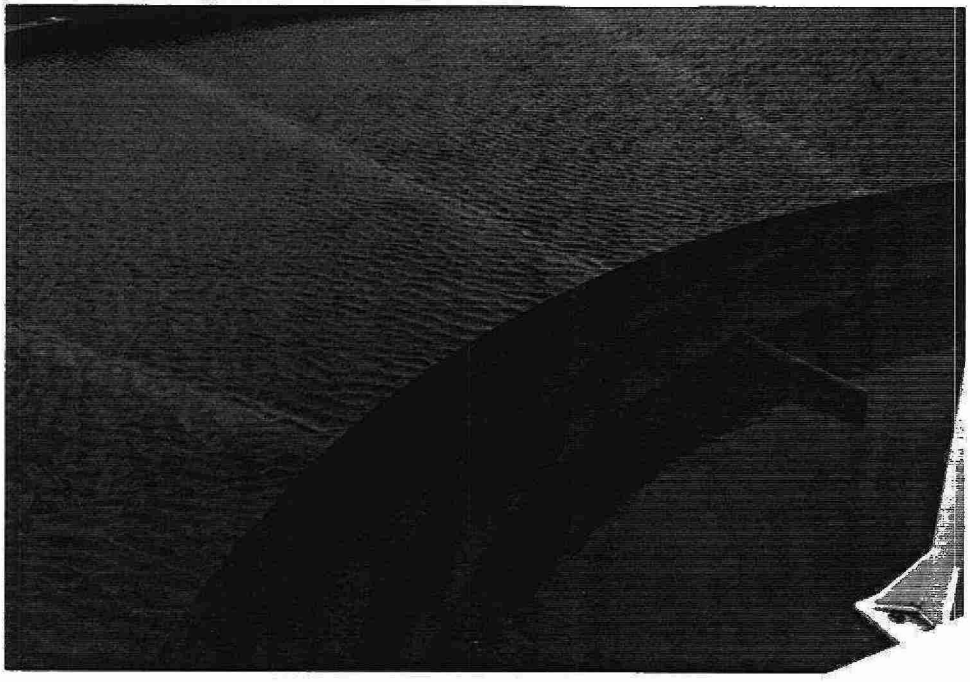
17. View of Clarifier No. 1



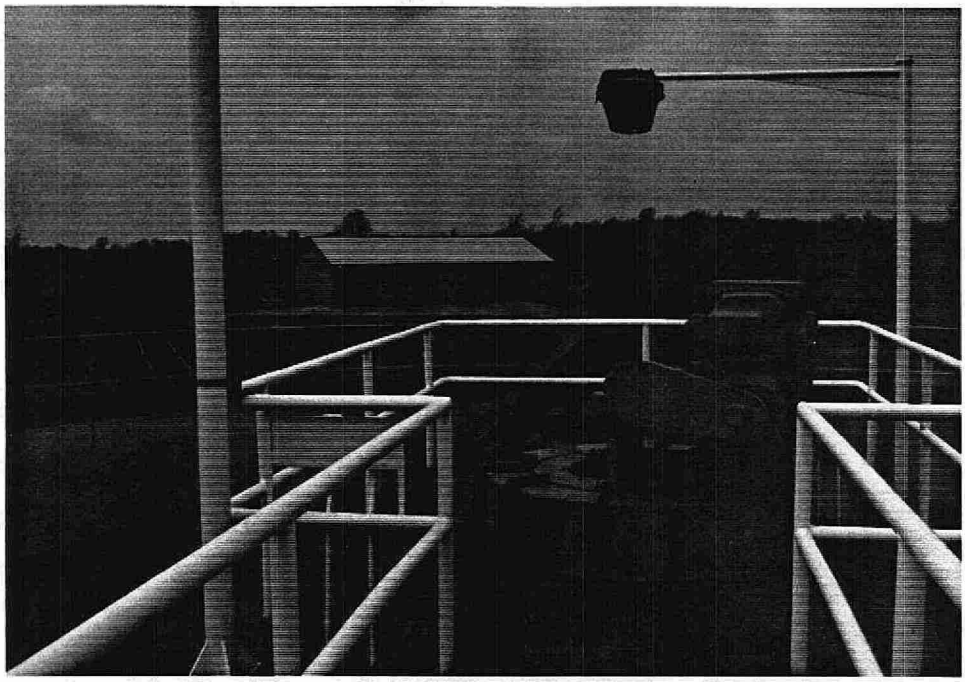
18. Clarifier No. 1 - Surface Launders Covered for Winter Operation



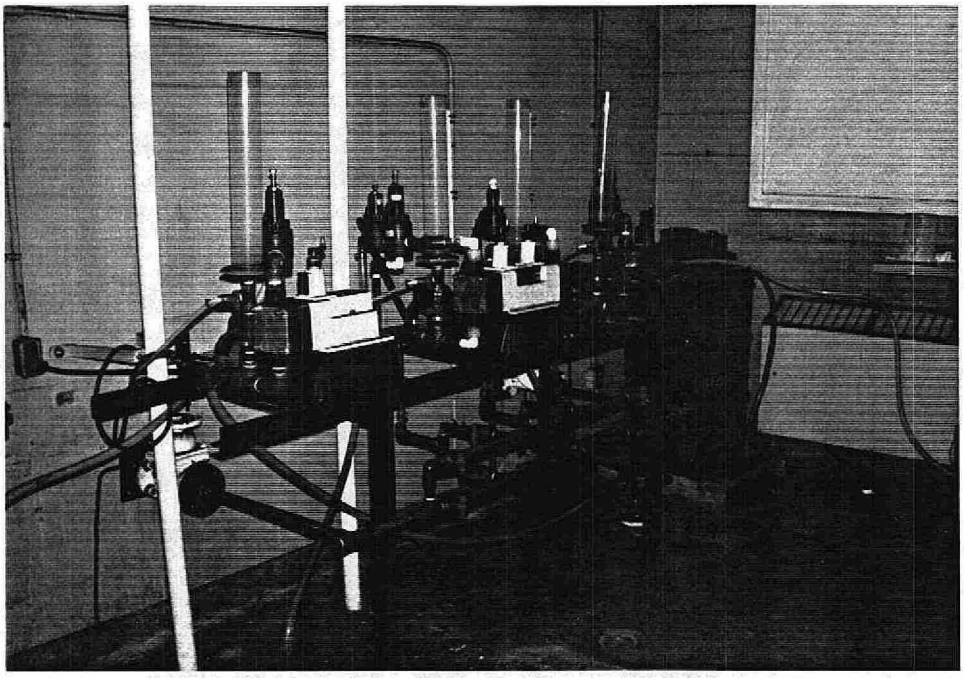
19. View of Clarifier No. 2



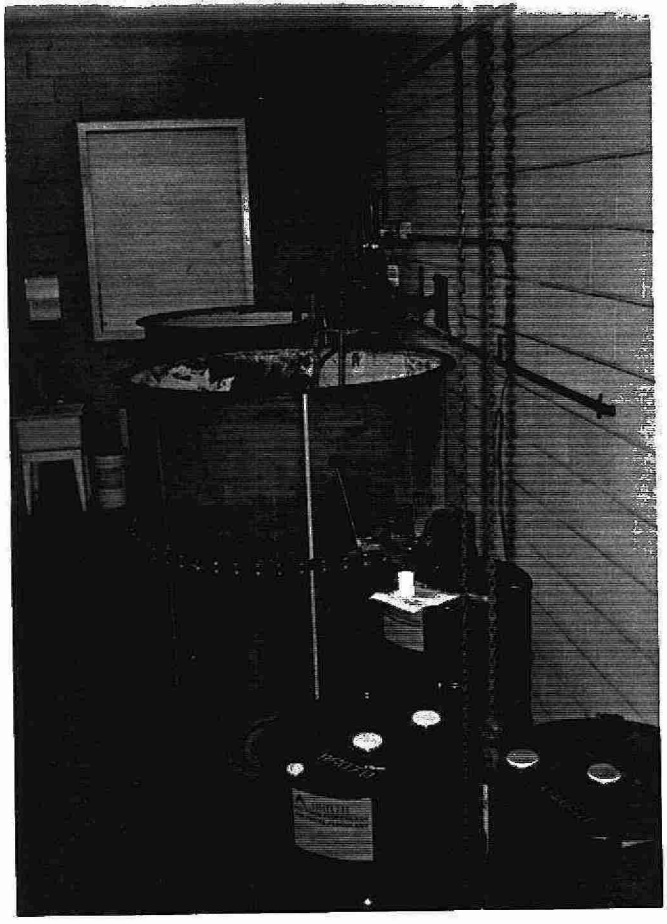
20. Clarifier No. 2 - Submerged Collector Pipes



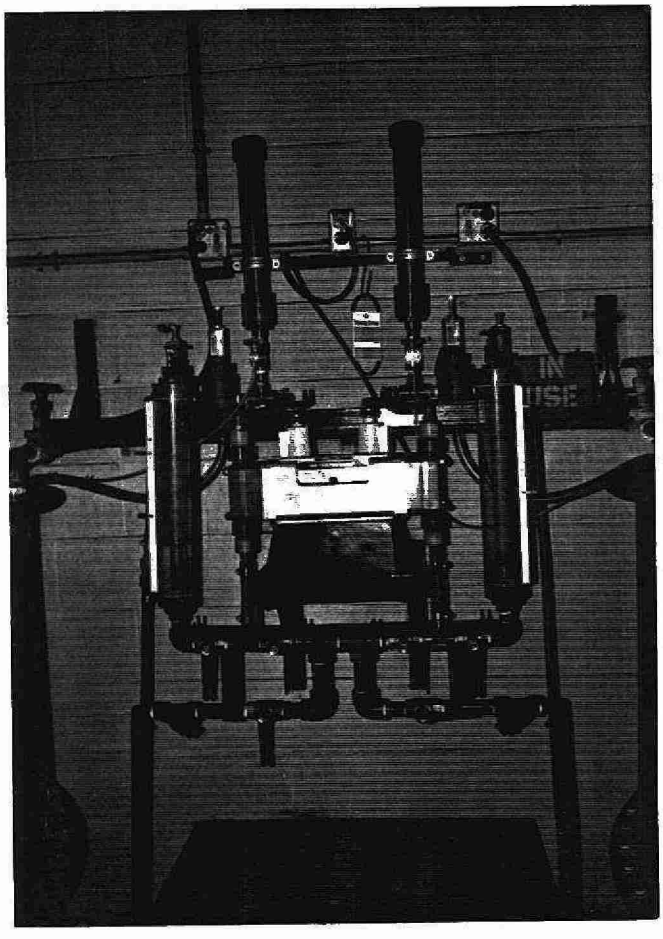
21. Clarifier No. 2 - Drive Unit



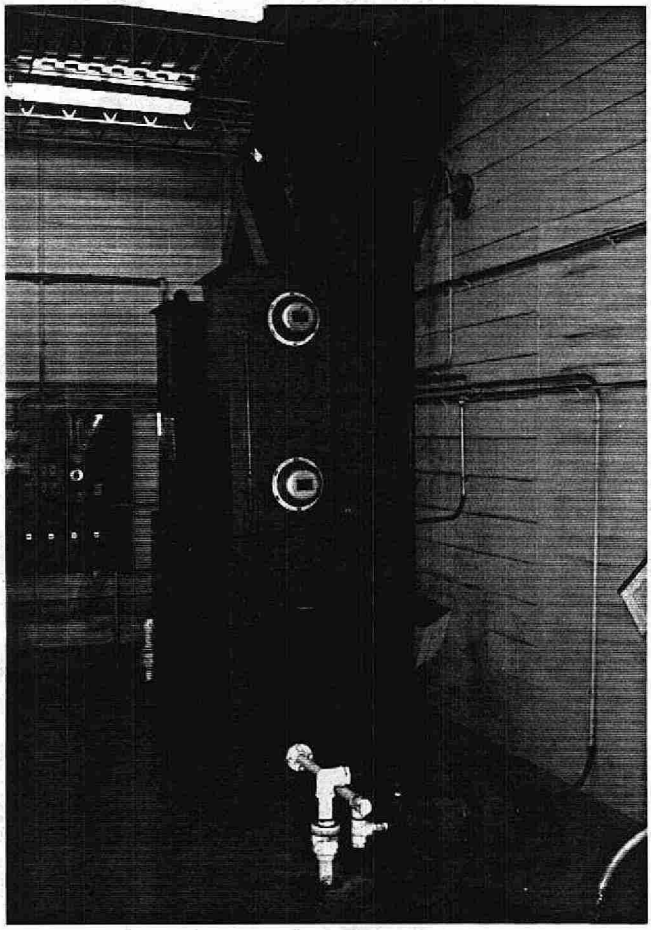
22. Liquid Alum and Polymer Pumps (Note Calibration Chambers)



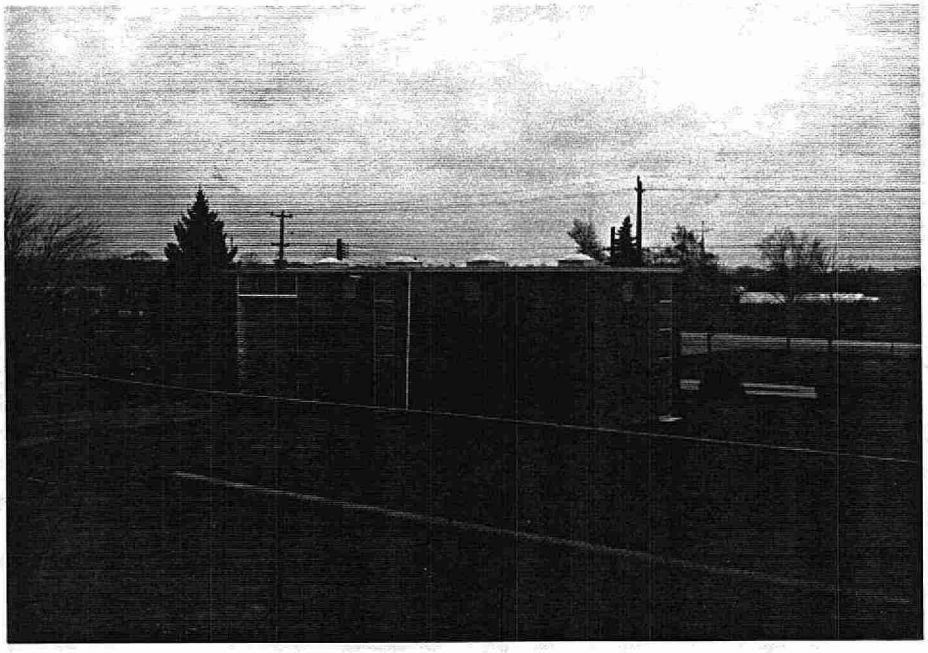
23. Polymer Mixing and Storage Tanks



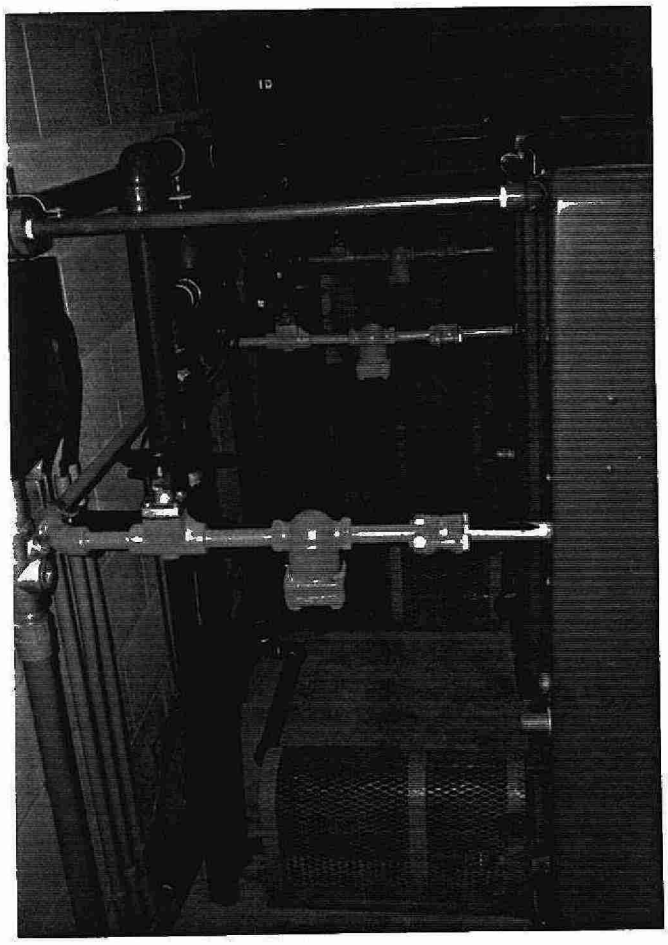
24. Polymer Feed Pump and Piping Arrangement



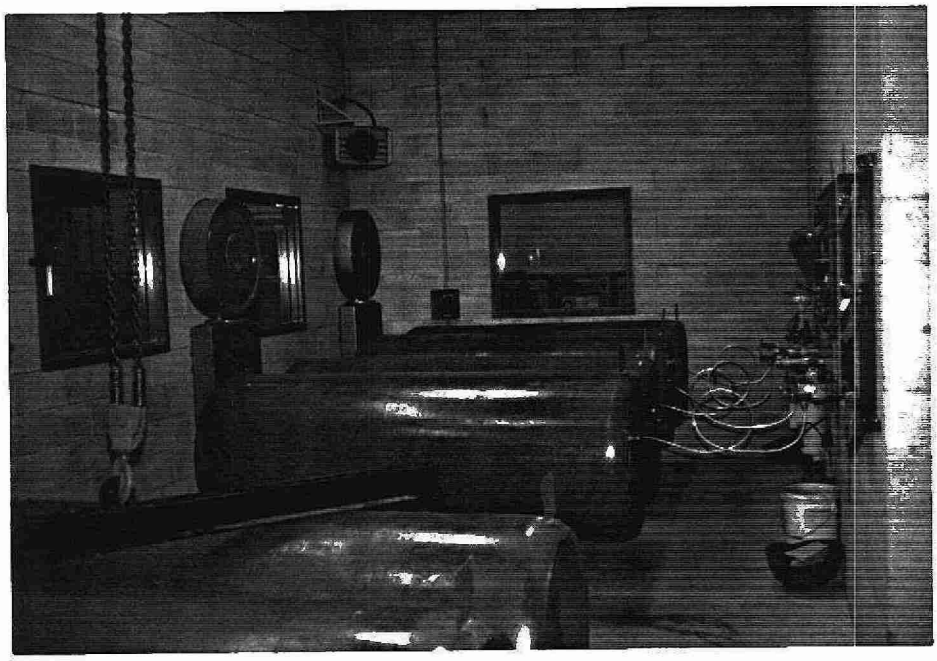
25. Activated Carbon Feeders and Feed Pump



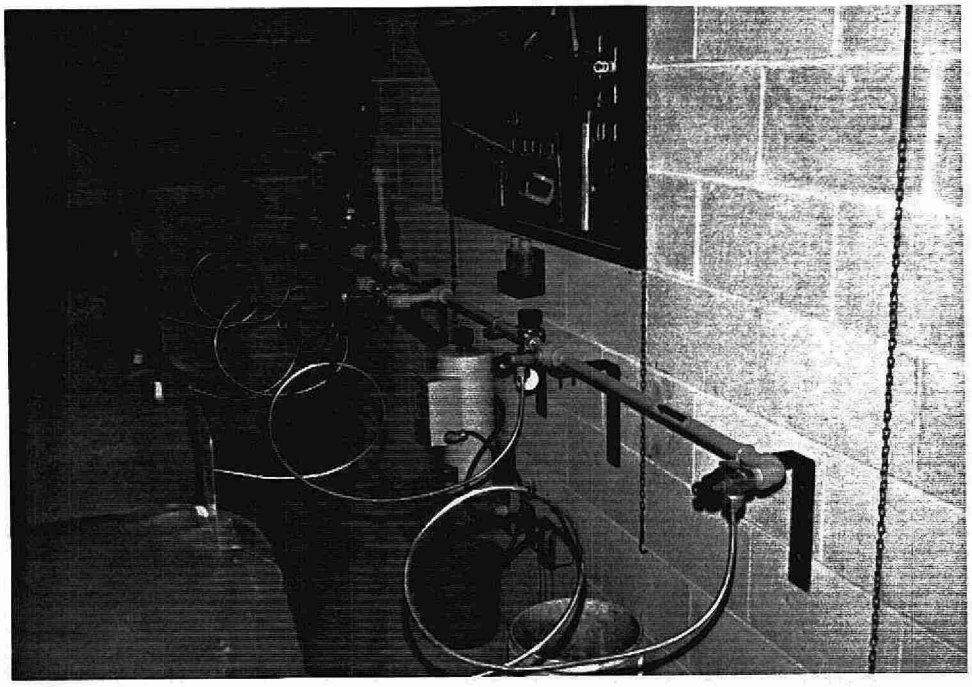
26. Chlorine Building



27. Chlorination Piping



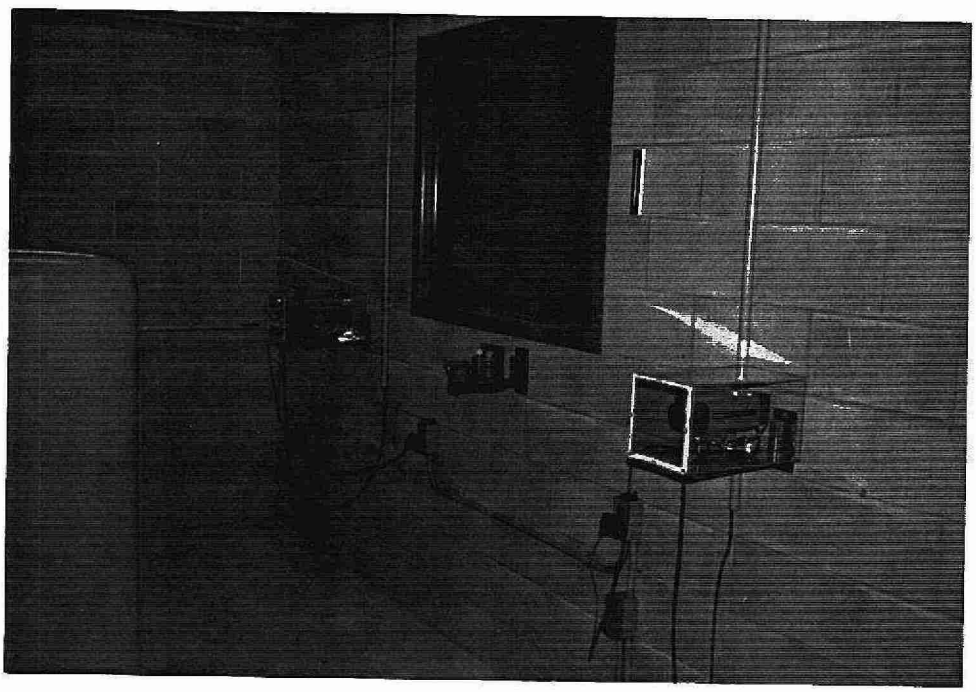
28. Chlorine Cylinder Storage Area



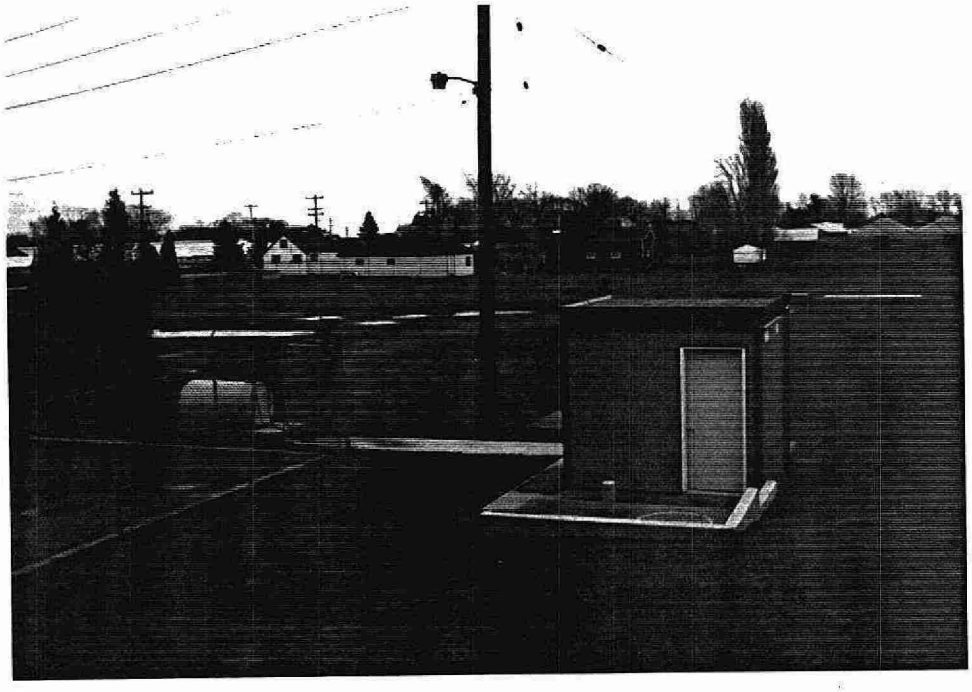
29. Chlorine Cylinder Manifold and Chlorine Gas Detector

30. Chlorine Cylinder Scale

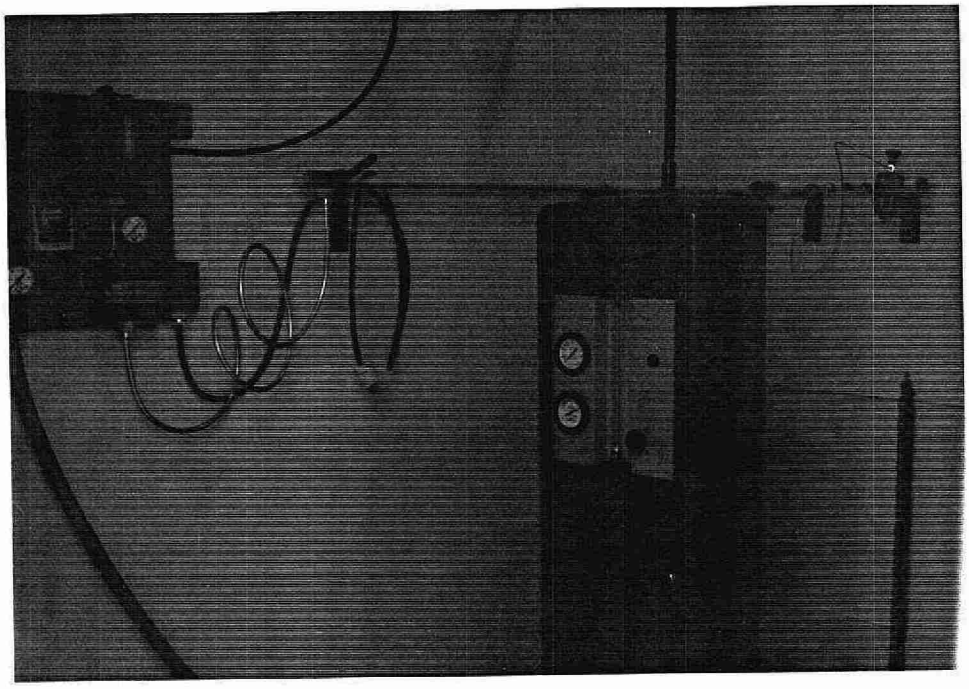
31. Chlorinators



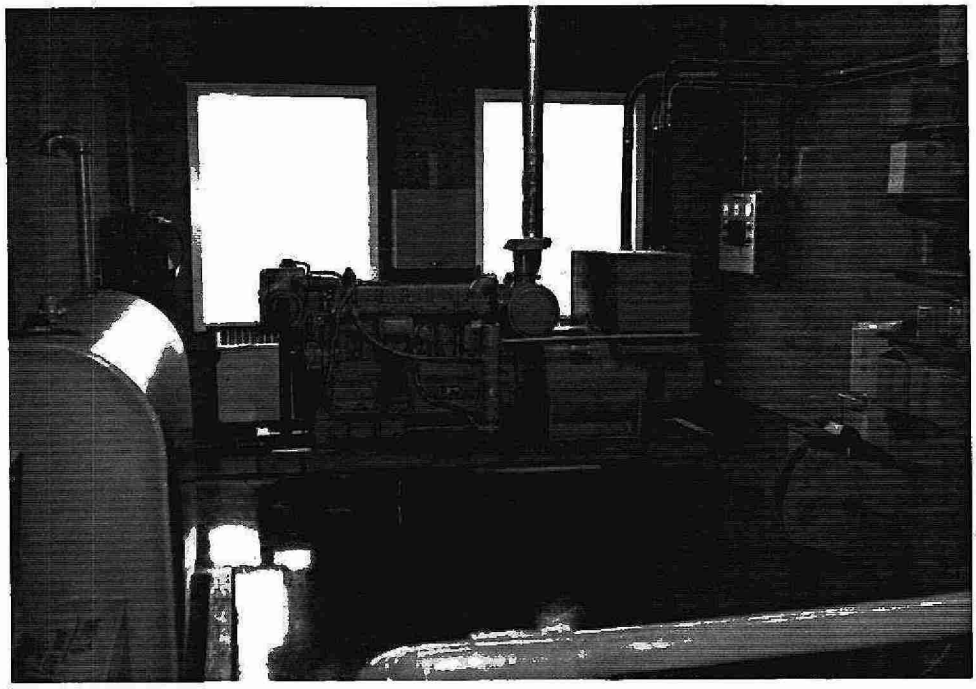
32. View Showing Television Cameras (Image of chlorinator rotameter transmitted to main control panel)



33. Emergency Chlorine Building

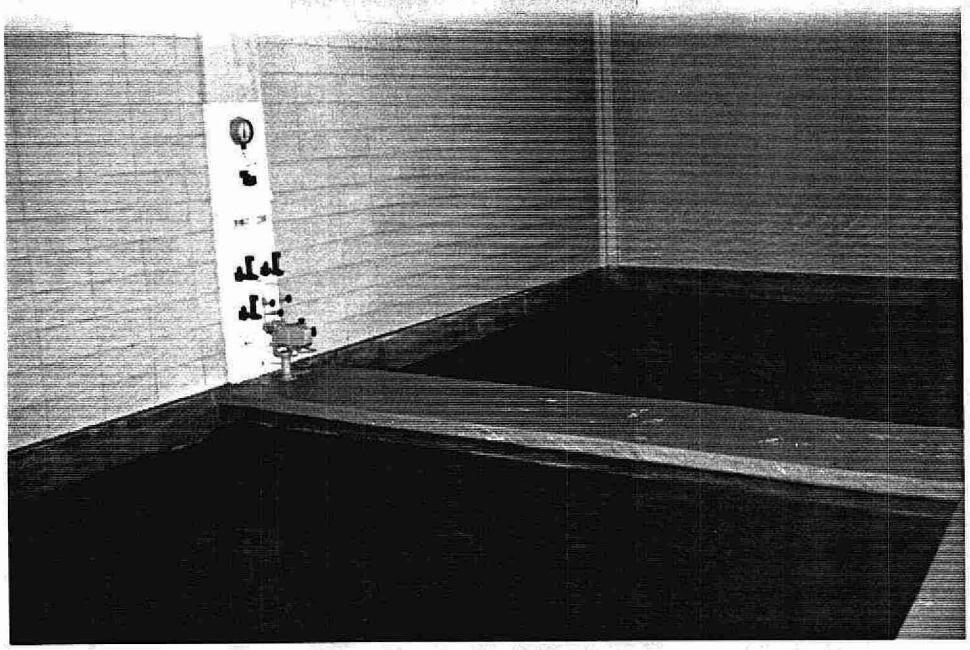


34. Emergency Chlorinators

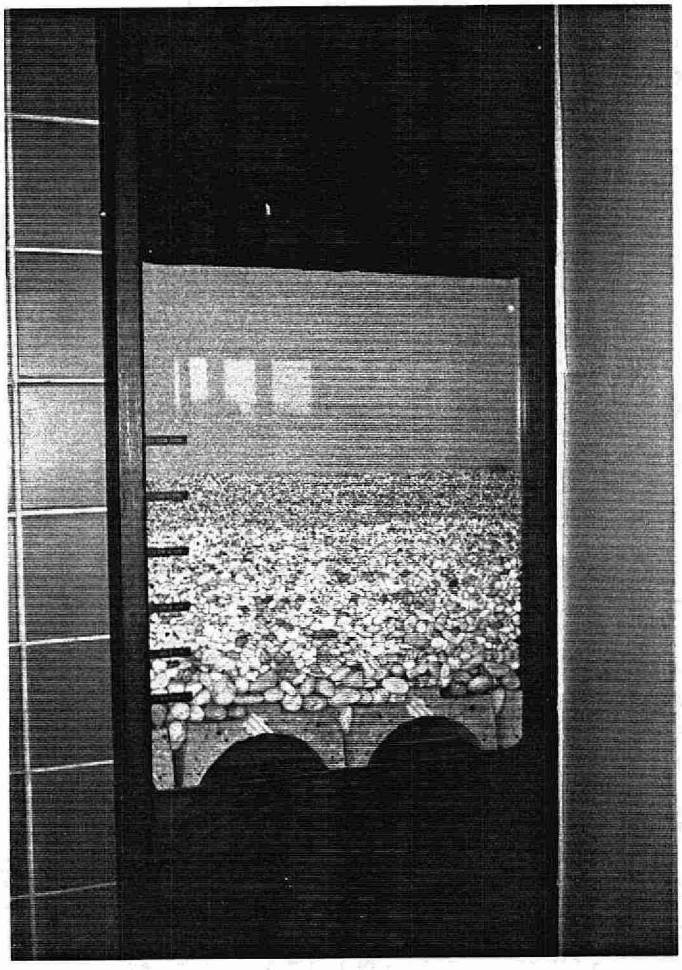


35. Diesel Engine Generator Set

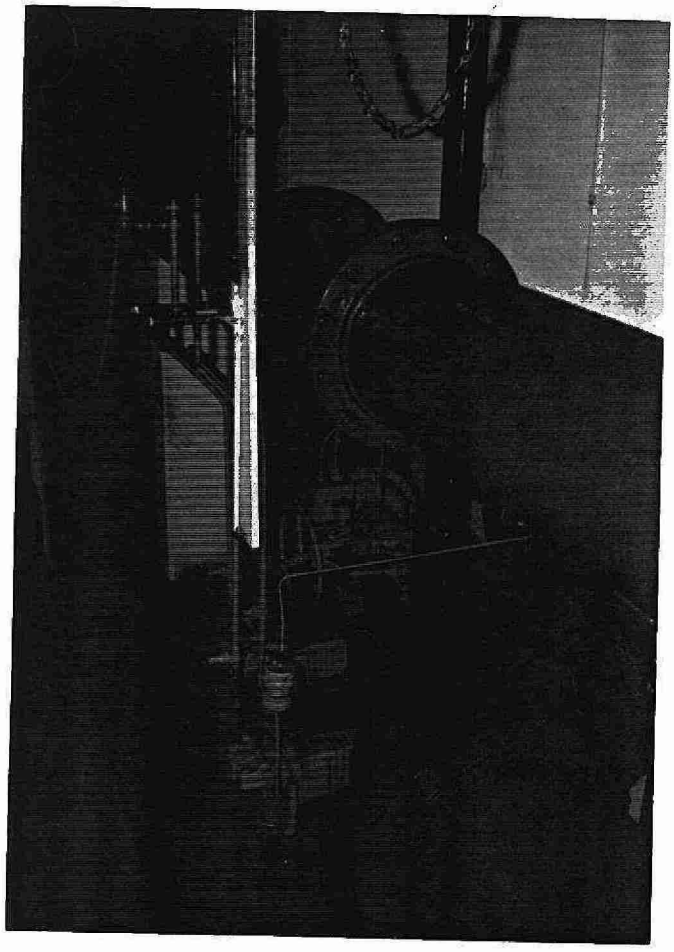
36. Filter Area



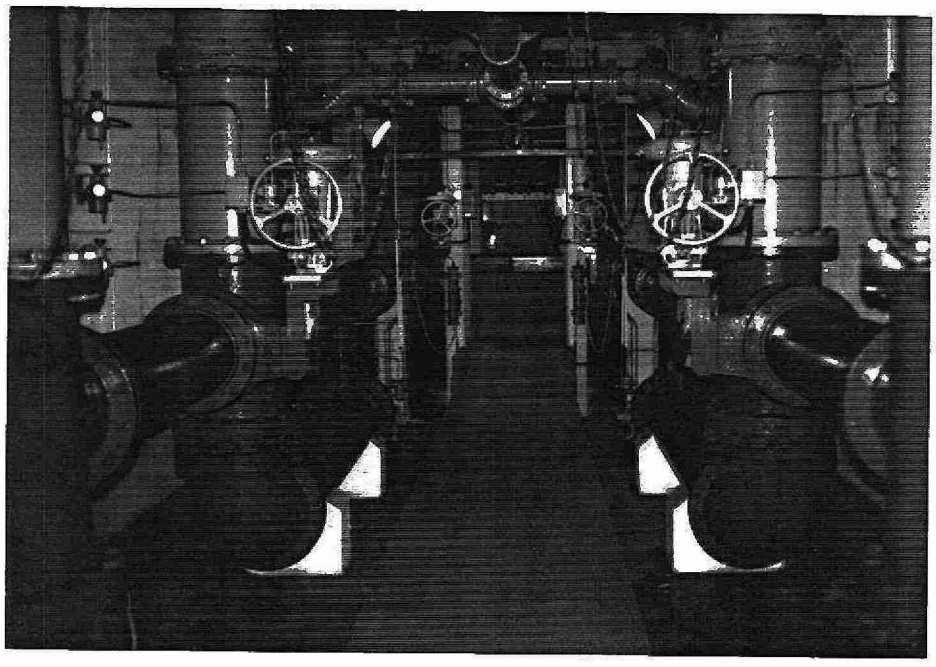
37. Top of Filter



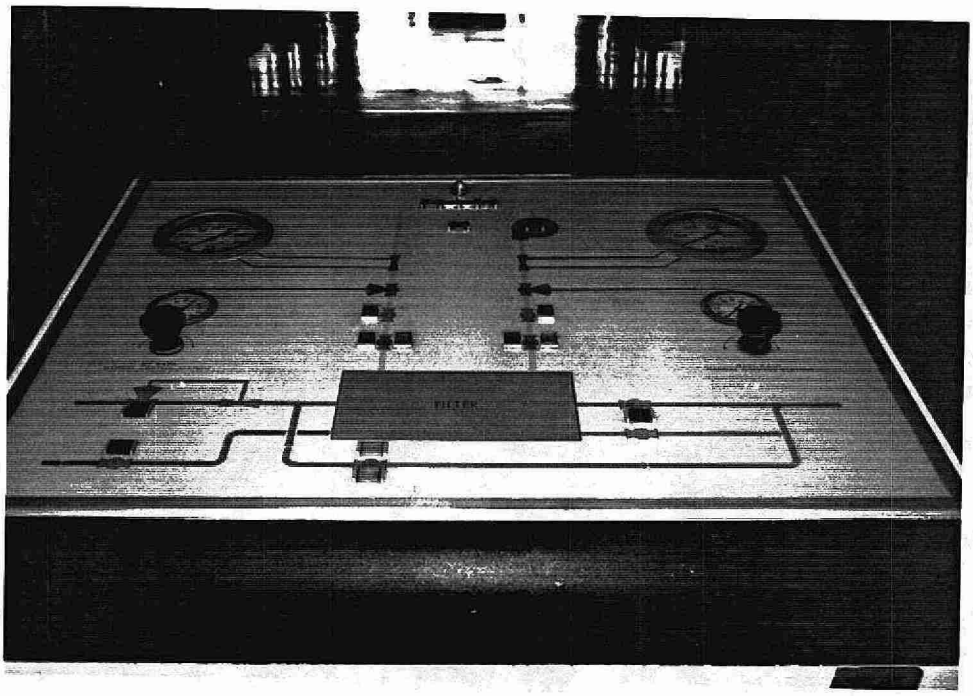
38. Display Case Showing Filter Media and Underdrains



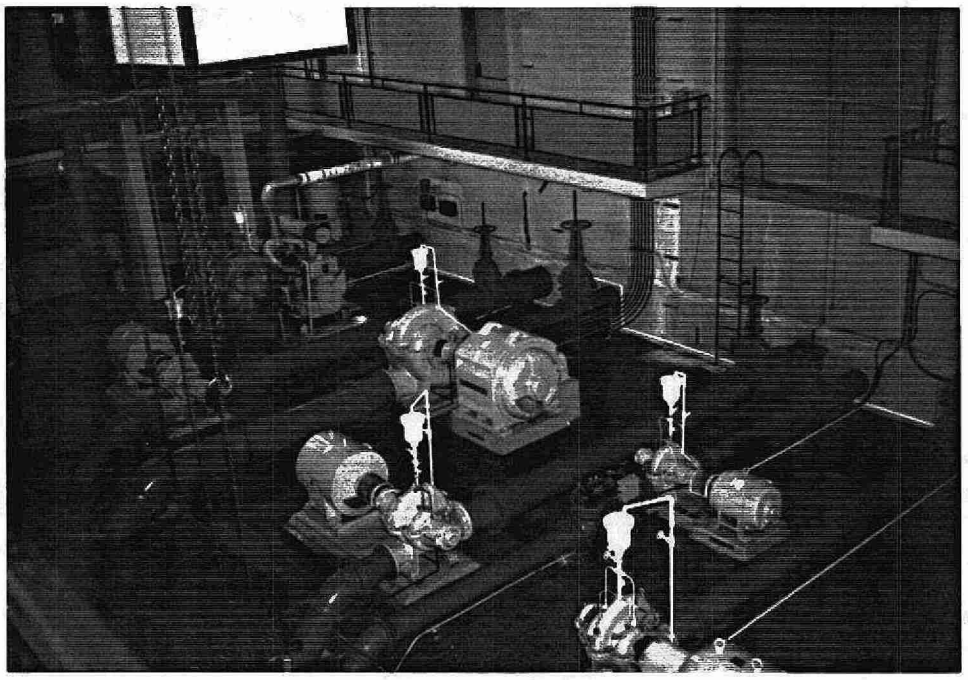
39. Filter Effluent Flow Measuring Instrumentation



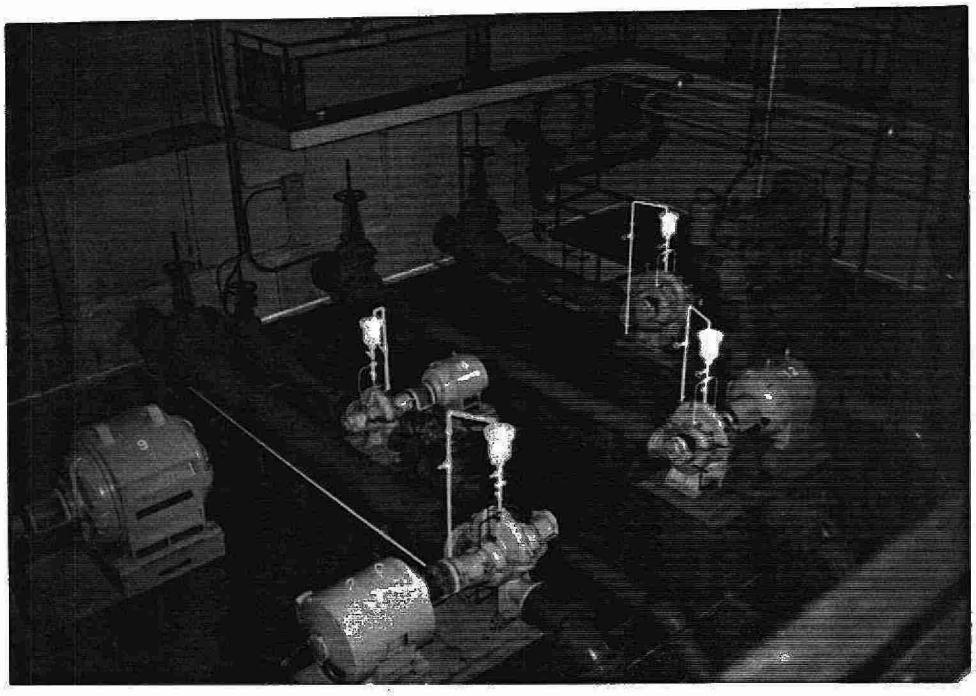
40. Filter Pipe Gallery



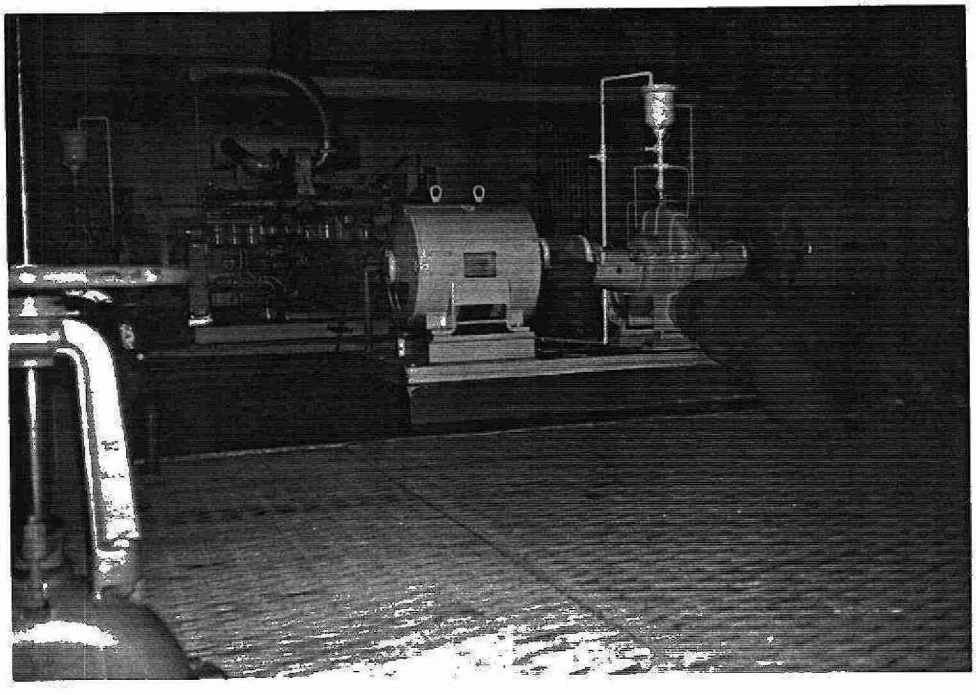
41. Filter Backwash Control Console



42. High Lift Pump Room

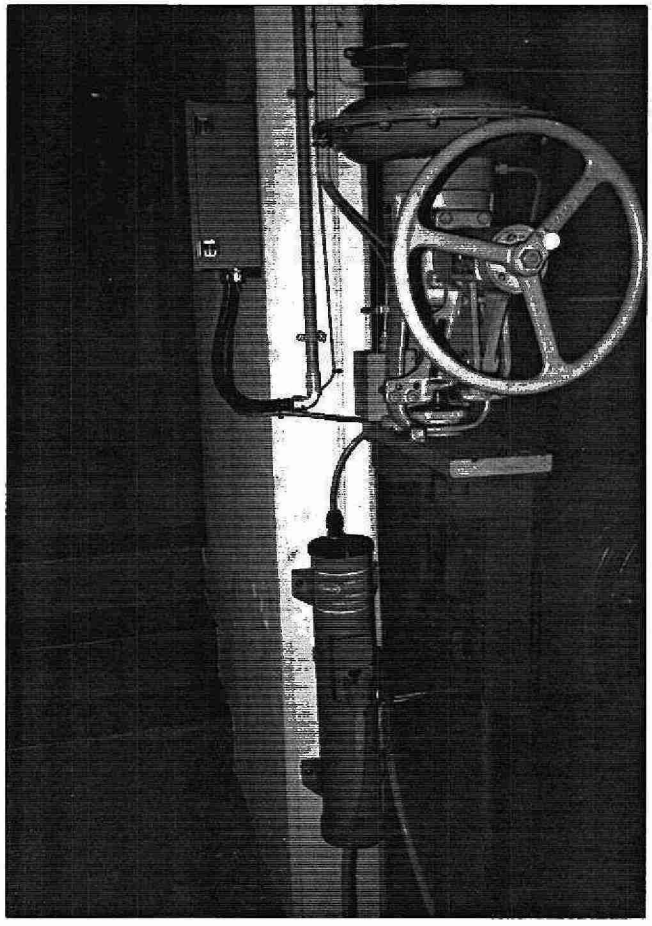


43. High Lift Pump Room

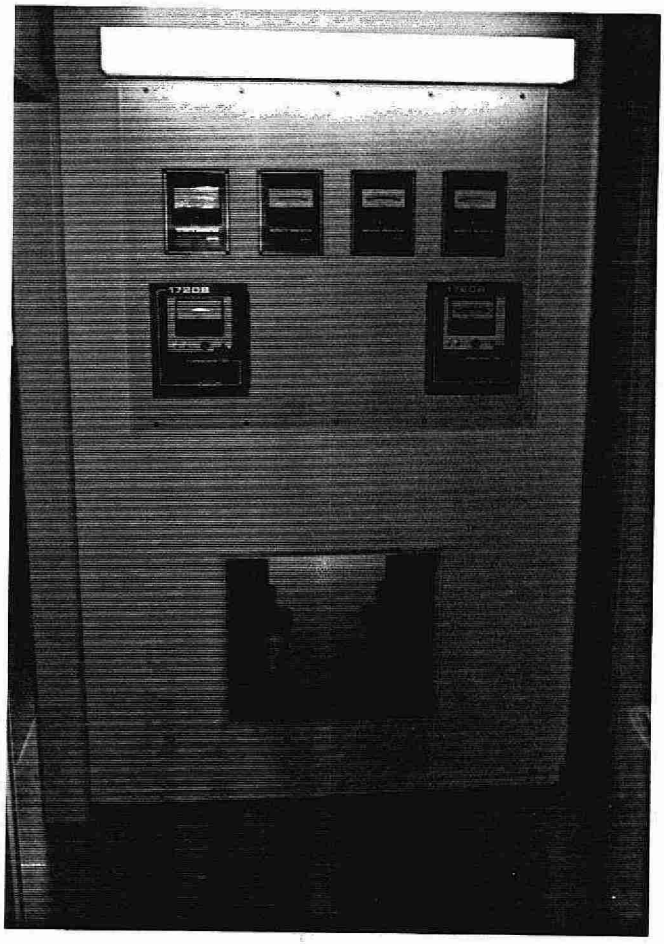


44. High Lift Pumps

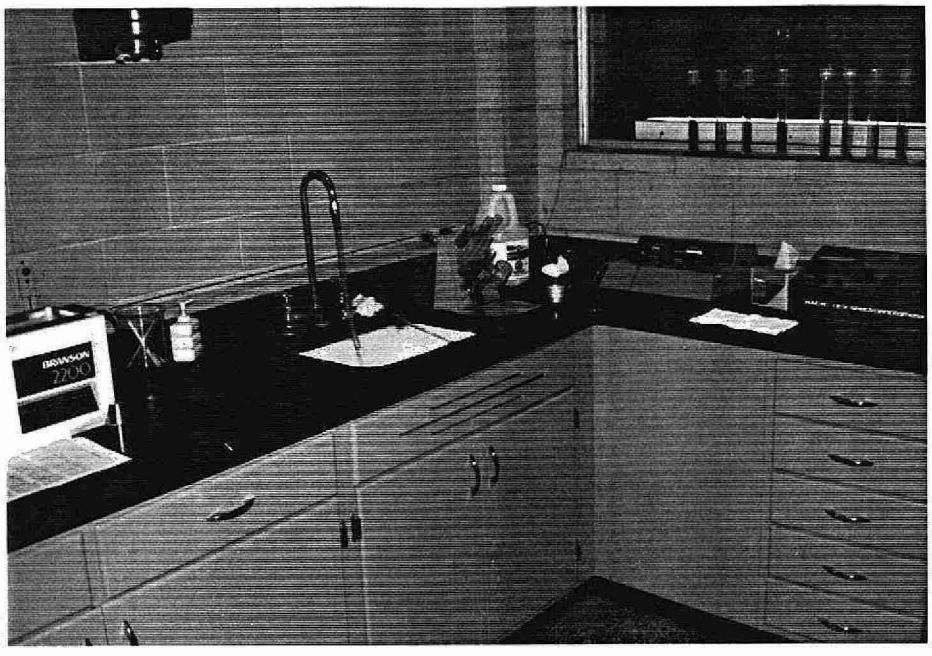
45. High Lift Pump Discharge Header



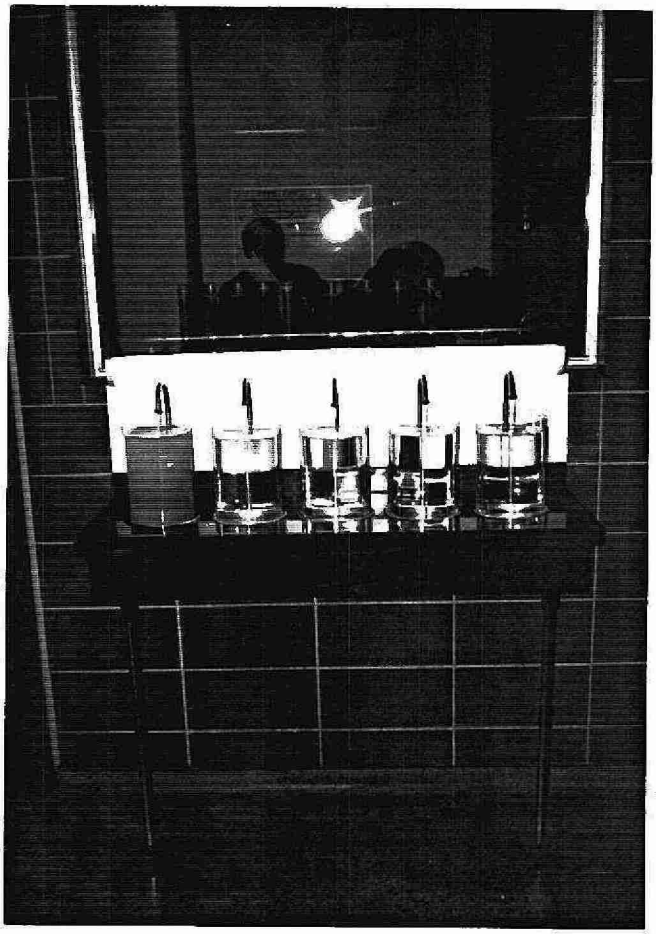
46. Filter Effluent Turbidimeter



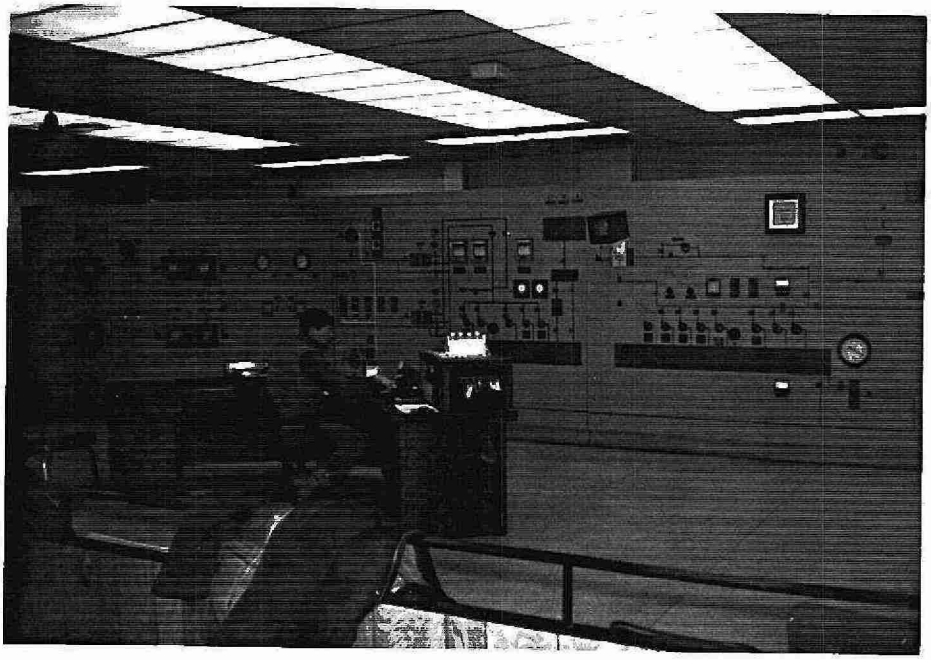
47. Turbidity Display Panel



48. Laboratory



49. Display Jars



50. Master Control Panel

SECTION D
PLANT OPERATION

D.1 Flow Control

The plant is operated manually with the ultimate controlling factor being the depth of water in the Leamington elevated water tank. High lift pumps are selected and started and stopped manually to maintain a depth of water in the tank between 6 and 8 metres (20 and 26 ft).

In response to the water level in the clear well and underground storage reservoirs, the plant operator will determine how many filters should be in operation and their flow rate settings. In addition to clear well and storage reservoir levels, the selection of filters also depends on the raw water flow, clarifier effluent and filtered water quality.

Except for the winter months, two clarifiers are in operation with the flow equally divided between them. The clarifier effluent from Clarifier No. 1 is collected through orifices in launders located at the water surface which creates problems during winter operation. Clarifier No. 2 has submerged collectors and because one clarifier is able to treat winter flows, only Clarifier No. 2 is in operation during the winter.

Both of the plant microstrainers are in operation at all times except for periods of maintenance during January and February.

Low lift pumps are turned off and on manually from the main control panel and pumps are selected for operation to meet the requirements of the filter flow rates. Flow splitting between the two clarifiers is accomplished by the adjustment of butterfly valves in the raw water supply piping.

D.2 Chemical Dosage Control

a) Alum

Liquid alum is pumped to the clarifier influent with chemical metering pumps. Alum dosage is determined from past experience and jar tests are carried out when raw water conditions do not allow determining proper dosage based on past

experience. Alum feed rates are adjusted manually whenever there is a change in raw water quality or flow. Each time the alum feed rate is changed, the operator verifies proper feed rate by the time-displacement method using the calibration chamber on the chemical feed pump. In addition, the feed rate is verified at the end of every shift from the total measured amount of alum used during the shift and the total volume of raw water treated.

b) Polymer

Alchem 8171-SC is used as a coagulant aid and is stored as a liquid in drums. Polymer is mixed in day tanks to a 0.1% concentration and is fed to the clarifier influent by chemical metering pumps. The required dosage is based on a very intensive jar testing program. Feed rates and dosages are altered and checked in the same manner as for alum.

c) Taste and Odour Control

Powered activated carbon (Hydrodarco B) is fed to the clarifier influent by a system incorporating a volumetric screw feeder, mixing tanks and slurry pumps. The water supply to the mixing tank run and the slurry pumps continuously. The plant operator manually activates the system every half hour, and the screw feeder runs for a time manually set to correspond to the raw water flow. Carbon is fed at a dosage of 2 mg/L. The volumetric feeder is calibrated every two months and periodic determination of dosage is made from the total carbon used and the total raw water flow for the same period.

d) Disinfectant

The chlorine storage and feed systems are in a separate building. Pre-chlorination chlorine is fed to the clarifier effluent to maintain a total chlorine residual of 0.20 to 0.25 mg/L in the filter effluent. Post-chlorination chlorine is fed at the inlet to the high lift pump suction well (clearwell) to maintain a total residual of 0.75 to 0.80 mg/L in the water leaving the plant. Chlorine feed rates are adjusted manually from the main control panel from which location the operator can view

the chlorinator feed rates via closed circuit television. Chlorine residual testing is performed 4 times per shift.

Daily chlorine dosage is reconciled by using the weight of chlorine used each shift and the total volume of water pumped during the same period.

D.3 Filter Backwashing Procedure

Filter backwashing is initiated manually and is manually carried out from the filter operating consoles. The decision to backwash is based on a combination of filter head loss, filter effluent turbidity and length of filter run. Under normal circumstances, the following criteria have been developed to ascertain when backwashing should be performed:

Head loss not to exceed 2.13 m (7 ft)
Effluent turbidity not to exceed 0.20 NTU
Length of filter run not to exceed 100 hours

During the summer months, the governing factor is usually head loss. During the fall, filter effluent turbidity and/or head loss govern backwashing and in the winter and spring, backwash is usually initiated on the basis of the length of the filter run. During peak flow periods in the summer, all the filters are backwashed daily during the low demand hours at night.

During backwashing, the main backwash water flowrate is increased slowly and then the surface agitators are turned on and operate for 1 to 2 minutes. Main wash is continued for an additional 5 to 7 minutes until the backwash water is clean. Although the capability exists, filtering to waste after backwashing is not practised at the plant. Plant management indicates the initial turbidity after backwashing is higher but clears quickly.

D.4 Filter Maintenance

Each filter is taken out of service annually and inspected for mudballs and media shifting. The surface agitator nozzles are examined and unplugged if required. Before being put back into service, the filter is backwashed slowly to remove entrapped air. All drains, inlets

and outlets are closed and 70% calcium hypochlorite (HTH) is added to the water on top of the filter to achieve approximately a 30 mg/L total chlorine residual. The filter drain is then opened to allow the chlorinated water to permeate the media. After 24 hours the filter is backwashed until the chlorine residual approaches normal levels. The high-residual chlorinated water is dechlorinated prior to discharge to drain.

The plant has a "filter peeker" which allows observation of the filter media at depth during backwashing. Additional anthracite is added as required to maintain proper depth.

A maintainence program entails the cleaning of the raw water wet well annually. The clarifiers are drained and cleaned every two years. The microstrainers are drained and cleaned with 12% sodium hypochlorite on a monthly basis. The microstrainers are also chemically cleaned with Alchem 1010 annually.

SECTION E
PLANT PERFORMANCE

E.1 Particulate Removal

a) General

The records indicate that particulate removal at the Union Water Treatment Plant is excellent. The following table indicates the treated water turbidity was 0.60 FTU or lower for over 99% of the time during the three year study period.

Turbidity Less Than or Equal to (FTU)	Percent of Time (Aug. 1983 to July 1986)
0.10	33.1
0.15	70.5
0.20	83.4
0.25	89.3
0.30	92.4
0.40	95.9
0.50	98.2
0.60	99.1

The treated water turbidity exceeded the Ontario Drinking Water Objective of 1.0 FTU on only two days during the study period. This occurred on January 4th and 5th, 1984 and is attributed to increased flows after the Christmas/New Year holiday period compounding the normal problems of winter clarifier operation (see below). Plant staff reacted by implementing the use of a filter aid and corrected the problem.

Since the beginning of 1986, the plant has operated under the instructions of the Regional Manager of Utility Operations to maintain a treated water turbidity of

0.20 FTU or lower. The following table, prepared from plant records for the first six months of 1986, indicates compliance with the instructions imposed on the plant.

Turbidity Less Than or Equal to (FTU)	**Percent of Time (Jan. 1986 to July 1986)**
0.10	59.9
0.15	95.3
0.20	100

The data indicates a significant improvement in particulate removal in 1986 compared to data for the three year study period. Plant records for the period August 1986 to December 1986 indicate daily turbidity did not exceed 0.20 FTU.

The improved removal has been accomplished by:

- More frequent filter backwashing
- Reducing filter loading rate, when possible, by placing more filters in operation for a given flow rate.
- Less concern about minimizing chemical costs.
- Installation of continuous turbidity indicating equipment which allows taking quicker corrective action.

b) Clarification

The average daily raw water turbidity ranged from 121.6 FTU to 1.2 FTU as follows:

Turbidity Less Than or Equal to (FTU)	Percent of Time %
122 (Maximum)	100
90	99
50	96
30	92
20	86
15	80
10	69
5	38
1.2 (Minimum)	-

Coagulant (alum) dosage averaged 19 mg/L ranging from 11 mg/L to 78 mg/L. Average coagulant aid dosage was 0.15 mg/L ranging from 0.05 mg/L to 0.50 mg/L. Clarifier effluent turbidity ranged from 0.15 FTU to 6.76 FTU averaging 1.1 FTU.

Problems in operating the clarification system occur during the winter months. The cold water/low raw water turbidity capacity of one clarifier is marginally adequate for winter demands. However, if both clarifiers are kept in operation, the low hydraulic loading results in severe icing conditions which presents the potential for damaging the mechanisms. In addition, the surface collection launders on Clarifier No. 1 freeze-up. In order to overcome this problem, baffles are installed temporarily to raise the water level and the launders are covered. Clarifier No. 2 has submerged collectors and, being more suitable for winter operation, has been the duty clarifier for winter operation since it was constructed in 1970.

Because of increased water demand, both clarifiers were kept in operation during the winter of 1986-87 with the previously mentioned modifications made to Clarifier No. 1. The higher flows and mild winter minimized icing problems.

During non-freezing weather, both clarifiers are in operation each treating one-half the total raw water flow. The major problem is that wind induced currents can upset Clarifier No. 2. Because of the surface launders, this does not occur in Clarifier No. 1.

Aluminum residuals and pH test results were examined in an attempt to assess the efficiency of coagulation/flocculation. Unfortunately, several factors make it somewhat difficult to assess the data. Firstly, pH determinations were not made prior to June 1986. In addition, from January 7, 1986 to April 3, 1986, one clarifier was in operation and polyaluminum chloride was used as the coagulant. From April 4, 1986 to June 23, 1986 both clarifiers were in operation with polyaluminum chloride used as the coagulant for one clarifier and alum for the other.

Aluminum residuals were recorded for the effluent of each clarifier and the plant effluent. The plant piping does not allow discharging the effluent from a specific clarifier to any particular filter, since the effluents of the clarifiers are mixed in the common filter inlet channel. Plant staff performed numerous jar tests during the polyaluminum chloride trial and experimented with different dosage rates. It was concluded that the polyaluminum chloride was more effective than alum in treating cold water and produced comparable results on the warmer water in the latter stages of the trial period. Alum has been used since the end of the trial period and no decision has been taken to use polyaluminum chloride on a continuous basis.

The records indicate aluminum residuals in plant effluent ranged from 0.01 mg/L to 0.21 mg/L during the three year study period. The residual averaged 0.06 mg/L and was 0.10 mg/L or less for 90% of the time. Assuming the aluminum residual in the raw water is very low, (no data available) it would appear the aluminum residual, at times, is higher than expected. It is difficult to assess the data since aluminum residuals on clarifier effluent and plant effluent are determined at the same time at approximately one week intervals. Thus, the clarifier effluent results

cannot be compared with plant effluent because of the residence time in the reservoirs. Aluminum testing on filter effluent would allow a better evaluation of the nature of the aluminum.

It appears, however, that aluminum residual in the plant effluent can be almost as high as in the clarifier effluent which would indicate the aluminum is in solution and not a precipitate.

During June and July 1986, the period of record for pH measurements, the pH of the raw water averaged 8.15 ranging from 7.75 to 8.40. Plant staff recently provided the following two sets of pH values at the locations indicated:

Raw Water	8.08	8.34
Clarifier Mixing Zone	7.54	7.53
Clarifier Effluent	7.53	7.38

The pH of the raw water is lowered by alum addition and mixing with previously formed floc but it approaches, and perhaps sometimes exceeds, the recognized upper pH limit for optimum coagulation with alum.

The conclusion that the aluminum in the plant effluent is in solution could be deduced as follows:

- The pH is low enough to allow aluminum to go into solution.
- The plant effluent aluminum residual is in the same range of values as clarifier effluent.
- Precipitated aluminum should be removed by filtration and settling in the reservoirs and therefore, the aluminum in the plant effluent should be lower than in the clarifier effluent.

It is understood that 0.10 mg/L maximum aluminum concentration has been established as a process-related objective for drinking water.

It is recommended that a testing and evaluation program be set up to determine the nature of the aluminum in the clarifier and plant effluent and investigate alternatives for lowering the pH. The program could be as follows:

1. Make pH determination on raw water, clarifier mixing zone, clarifier effluent, filter effluent and plant effluent.

2. On the same set of samples as in (1) above, test for aluminum residual.

The tests should be done daily for at least one week's duration at different times of the year to obtain data representative of the raw water quality and temperature conditions that can occur. The plant records seem to indicate higher pH values in the summer months which could be indicative of algal activity and tests should be made during this period.

If it is found that the aluminum is in solution and its concentration in the plant effluent must not exceed 0.10 mg/L, additional testing will be required to determine the most effective way of reducing its concentration.

A major factor affecting particulate removal in a solids contact up-flow clarifier is sludge management. At the Union Plant the clarifiers have sampling ports (4 in Clarifier No. 1, 5 in Clarifier No. 2) to the draft tube and reaction zone. Samples are taken on weekdays. The samples are allowed to settle for 10 minutes in 100 ml graduated cylinders. From the results of the settling tests, together with other factors such as time of year, water temperature, flow rate, etc., plant staff is able to determine the appropriate sludge blow-down sequence. Sludge blow down is initiated manually every hour or half-hour depending on the amount of sludge produced. Initiation of blow-down opens the sludge blow-down valve and starts a timer. When the timer times out the valve closes and the timer resets. The timer is set to maintain suitable sludge blanket conditions. The level of the sludge blanket is determined visually during the summer. During the winter, ice prevents visual observation and the approximate sludge blanket elevation is determined from the sampling points noted above. In addition to indicating the condition of the sludge, samples from the draft tube give guidance regarding the selection of turbine

speed. Decisions regarding sludge blow-down cannot be based on a hard-and-fast set of rules. They are more properly made based on the operator's familiarity with the past performance of the system under varying conditions. The Union staff seems to be able to manage the clarifier sludge satisfactorily. The installation of sludge blanket level detectors and making provision for more easily obtaining sludge samples would be an asset.

As mentioned earlier, coagulant and coagulant-aid dosages and feed rates are adjusted manually. Plant management feels this gives the operation staff some responsibility, an incentive to learn about the processes and make independent decisions regarding their operation. The rigorous data recording system keeps the operators active and in constant touch with the plant operation. This has merit in that it keeps the operator interested in his job which tends to discourage production of a lackadaisical effort.

During March of 1987, a streaming current monitor was installed for a two week trial. While the device reacted to varying raw water conditions, it has not as yet been determined if the benefits of the equipment justify its high cost (ie. approximately $10,000).

Because the clarifiers are not covered, they are affected by weather conditions and it is doubtful if improvements could be made in clarifier operation to significantly reduce the particulate matter in the plant effluent.

c) Filtration

Figures 8 and 9 show typical filter performance. Figure 6 indicates a marked increase in effluent turbidity when the flow was increased after approximately 55 hours of filter run. An increase in flow earlier in the run did not affect effluent turbidity significantly.

Since filter effluent turbidity is recorded hourly, the expected peak in turbidity after placing a backwashed filter into operation is not registered. On March 5th, 1987, a test was run on Filter No. 1 to track effluent turbidity after placing a recently backwashed filter into operation.

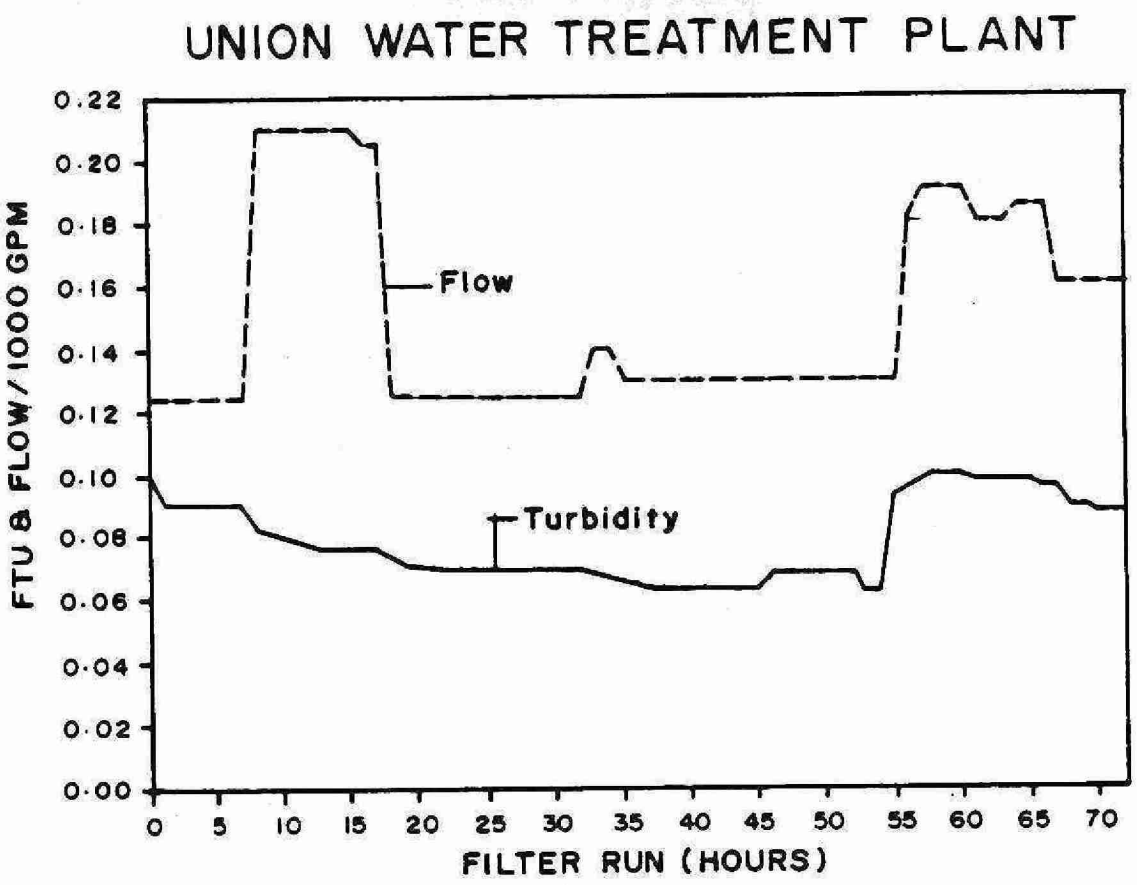


FIGURE 8 — Filter Performance July 19-22, 1988

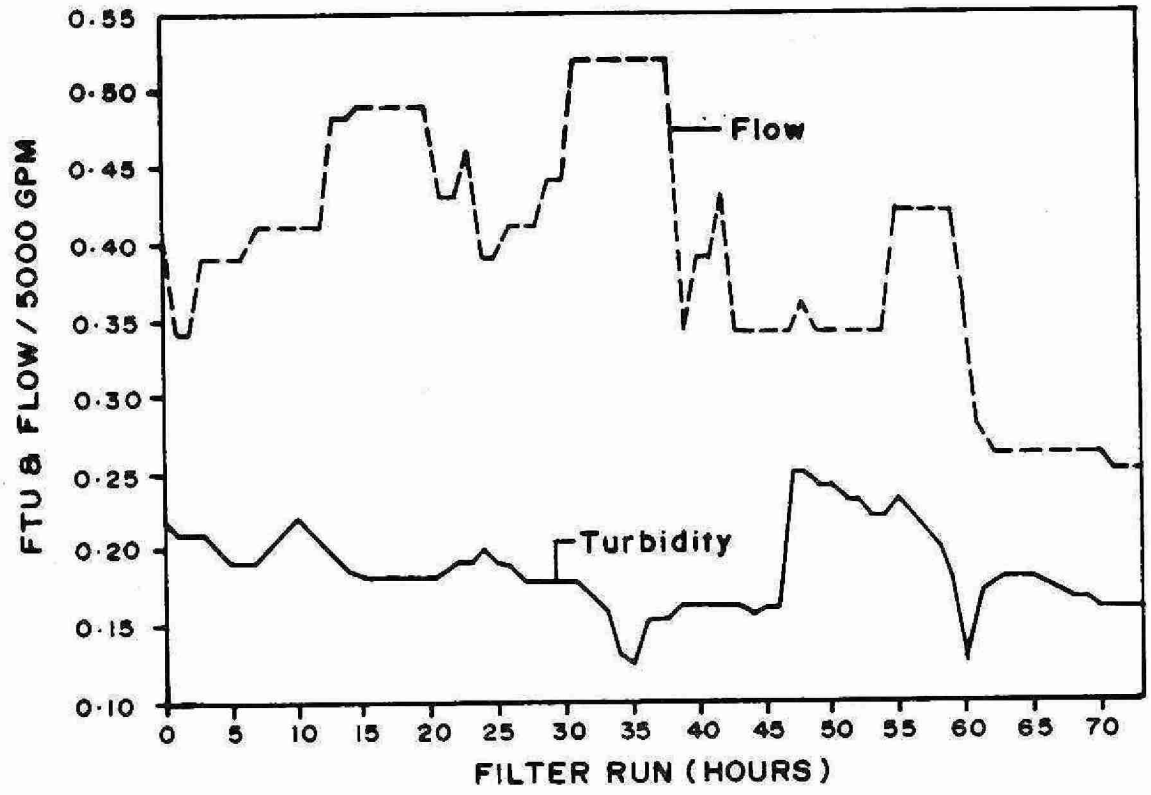


FIGURE 9 — Filter Performance Aug. 14-17, 1988

Filter No. 1 was taken out of service after a run of 60.5 hours The effluent turbidity at the end of the run was 0.06 FTU. Each half of the filter was backwashed in the normal manner. The turbidity of the water in the filter at the completion of backwashing was 3.2 FTU in one half and 2.1 FTU in the other half.

After placing the filter into operation, turbidity readings were taken at 1 minute intervals for 50 minutes and at 1 hour intervals thereafter until termination of the filter run 56 hours later. Filtering rate was 6.79 m/h (2.3 gpm/sq ft) for the first 33 hours of the filter run and 4.53 m/h (1.54 gpm/sq ft) thereafter.

Figure 10 shows the test results graphically. The discontinuity in the turbidity curve at 50 minutes is a reflection of the change from turbidity readings being taken every minute to every hour. It can be seen that the effluent turbidity increased from 0.078 FTU to a maximum of 0.16 FTU 13 minutes into the filter run. From 13 minutes to 50 minutes the rate of decrease in turbidity dropped considerably and was reasonably constant from 50 minutes to the end of the run.

During the first 50 minutes of filter run (ie. 1.46% of the total filter run) approximately 3.1% of the total turbidity load is produced giving a turbidity load/run time ratio of 2.12. The average ratio for the remainder of the run was 0.95 if the first 50 minutes of the filtered water was wasted, the total turbidity load for the filter run would be reduced by only 1%.

However, in the initial stages of the filter run, before the filters have ripened, the filter will permit material to be flushed out. Turbidity, bacteria and other contaminants will pass through the filter and it would seem prudent to reduce the initial turbidity even though its contribution to the total turbidity load is small.

Taking optimizing particulate removal to mean making it as perfect as possible, the following could be considered to achieve that objective.

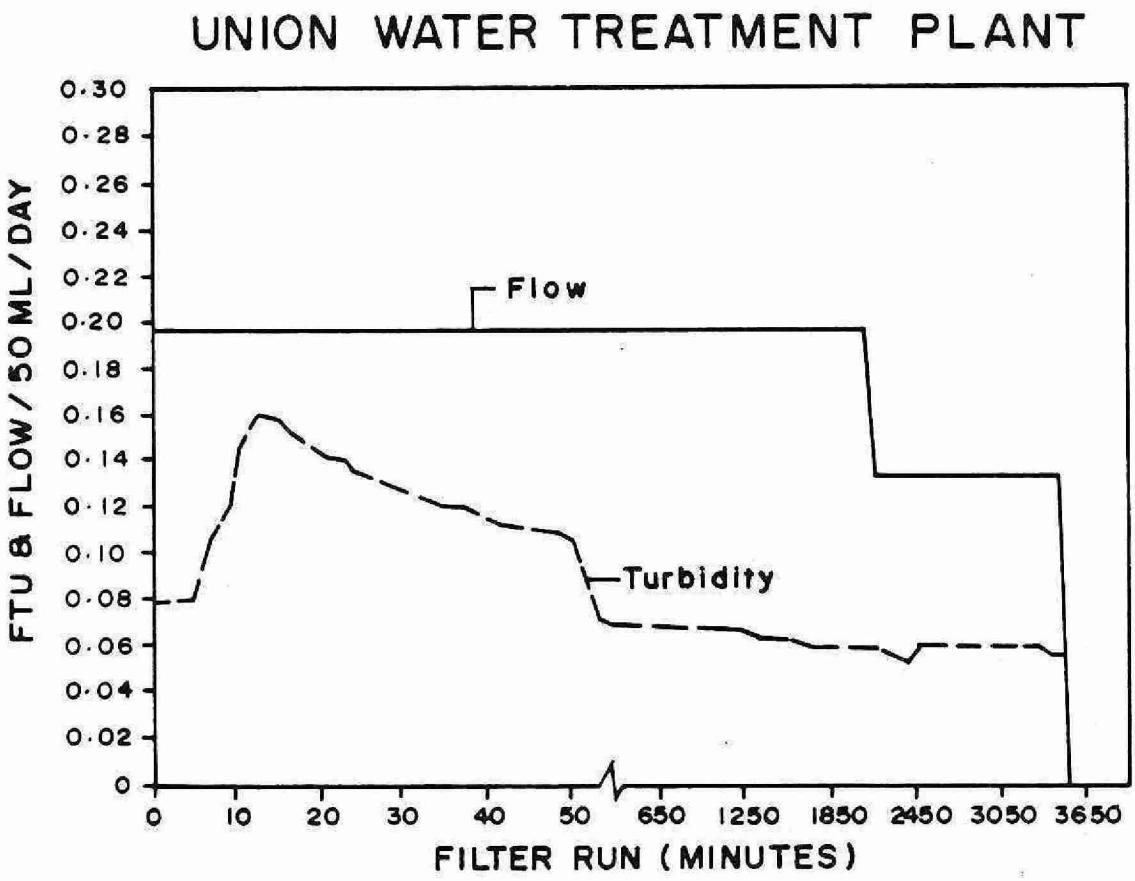


FIGURE 10 – Filter Performance Mar. 5-7, 1987

a) Filtering to Waste

The previously described test indicates a peak in filter effluent turbidity which could be eliminated from the plant effluent by filtering to waste for 30-50 min. after placing a backwashed filter into operation.

Additional tests should be done to confirm the presence of the turbidity peak under different filter flow rates and filter influent conditions. The highest initial turbidity readings will probably occur during the high demand period in summer months and the reduction in plant capacity resulting from filtering to waste might not be tolerable.

b) Filter Flow Control

It is recommended that changing filter flow rates during a filter run be minimized and that increasing filter flow when the filter is well into its run be avoided. When flow adjustments are required, the should be made gradually.

Filtering at a low rate for a time after placing a backwashed filter into operation could be effective in reducing the initial turbidity peak.

c) Backwash Water Conditioning

The literature suggests that in some locations, the addition of polymer to the backwash water results in a reduction of the initial turbidity after placing a backwashed filter into operation. Tests would have to be done to determine the effectiveness of this procedure and the most suitable type and dosage of polymer.

d) Filter Aid

The use of a polymer, injected into the filter influent stream would probably reduce effluent turbidity. Again, testing would have to be done to

determine the effectiveness of using a filter aid type of polymer and dosages required. The reduction in plant capacity resulting from shorter filter runs and more frequent backwashing that would likely occur with the use of a filter aid would cause problems during high demand periods.

e) Backwash Duration/Rate

Increasing the backwash water flow rate and/or the duration of backwashing might be effective in reducing the initial turbidity although a dramatic improvement would probably not be realized.

However, the backwash water flow rate could not be increased without raising the top of the wash water troughs to prevent excessive loss of anthracite media.

E.2 Disinfection

Plant practise is to feed chlorine into the clarifier effluent to maintain a total chlorine residual of 0.20 to 0.25 mg/L in the filter effluent. Post-chlorination is carried out to maintain 0.75 to 0.80 mg/L total chlorine residual in the plant effluent as directed by the Regional Manager of Utility Operations.

Chlorine demand tests are not carried out and only total chlorine residual is determined.

Prior to 1985 05 07 chlorine was added to the clarifier influent. At that time there was concern about the formation of Trihalomethane compounds and the application point for pre-chlorination was changed to the clarifier effluent. Examination of the WPOS Water Quality - 4 Year Summary Table (Page 5) indicates a substantial reduction in Trihalomethanes in 1986 as compared to previous years. The total average values for 1986, 1984 and 1983 were 29, 48.7 and 54 respectively. In addition to reduction of trihalomethanes, the change in application point for pre-chlorination reduced the chlorine dosage by approximately 50% with no serious effect on the treatment process. The only detrimental effect was a slight increase of algae growth in the clarifiers.

Table 7.0 - Bacteriological Testing indicates the absence of coliforms in all samples of water leaving the plant during the study period. The plant superintendent advised an occasional sample from the distribution system has had a positive test result. Most of these occurrences can be attributed to particular events such as watermain repairs being made just prior to sampling. Since watermain maintenance is the responsibility of the various municipalities served by the Union Water Treatment Plant, the Union Plant staff, who collect the samples, might not be aware of watermain repairs being made. Whenever positive tests are obtained, resampling and testing are done immediately and to date there has not been a situation that would indicate inadequate disinfection at the plant has resulted in positive bacteriological test results in the distribution system.

It can be concluded therefore, that the plant is capable of disinfecting the water to ensure a water quality as described in the Ontario Drinking Water Objectives (M.O.E.).

In the normal mode of operation, filter effluent discharges to Reservoir No. 1 (9090 m^3 or 2 mil gal). Reservoir No. 1 discharges to Reservoir No. 2 (13,636 m^3 or 3 mil gal) and Reservoir No. 2 discharges through a pipe to the Clearwell (High Lift Pump Suction Well). Both reservoirs are baffled such that short circulating is minimized. At peak pumping rates of 95.5 ML/d (21 mgd), the detention time in the reservoirs is 5.7 hours when they are full and 3.8 hours at low level. During periods of low demand, detention time in the reservoirs could approach 24 hours.

The application point for post-chlorination is upstream of a baffle at the inlet to the clearwell. This is not ideal in that even if complete mixing of chlorine in the incoming flow is achieved, the detention time in the clearwell is only 7.2 minutes at peak pumping rates. For water pumped by the pump nearest the inlet, the detention time would be negligible.

Since chlorine residual of the water entering the clearwell is not determined prior to post-chlorination, it is not possible to determine the loss of chlorine residual through the reservoirs.

The plant does not have facilities for measuring the weight of chlorine used for pre and post-chlorination separately and the chlorine dosages in Tables 3.0 and 3.1 are estimated values. The sum of the dosages does not necessarily reflect the actual total chlorine used due to inaccurate flow measurement.

The plant has two chlorine weigh scales each accommodating two 0.9 tonne (2,000 lb) containers. The containers are connected to a common manifold which serves the three chlorinators. It would be feasible to duplicate the manifold such that the containers on one scale would feed the pre-chlorinator and the containers on the other scale would feed the post-chlorinator. The manifolds would be interconnected and valved to allow flexibility of operation. This modification would allow accurate recording of pre and post-chlorination dosages.

It is recommended that the water upstream of the clearwell be tested for chlorine residual. This would allow determination of loss of chlorine residual through storage.

This information could be used to determine the feasibility of increasing pre-chlorination dosages such that post-chlorination could be eliminated or reduced to overcome the inadequacy of the post-chlorination application point. This would have to be considered carefully since increased chlorine applied to the clarifier effluent could cause corrosion of the building materials enclosing the top of the filters and the equipment in the space. (ie. aluminum curtain wall, light fixtures, copper tubing, etc.).

The water does not appear to be aggressive or present significant taste, odour or other problems that would warrant an investigation of alternate forms of disinfection.

SECTION F
RECOMMENDATIONS

The report indicates particulate removal and disinfection at the plant are very good and any modifications would probably result in only minor improvements. However, the following could be considered for implementation. A plant expansion program is presently underway and the long term modifications should be included in that program.

F.1 Short Term Modifications

1. Expand the **aluminum testing program** to determine if pH correction of the raw water is warranted to improve treatment and/or reduce aluminum residual in the plant effluent.

2. **Modify operational procedures** to evaluate the effectiveness of the following on particulate removal.

    a) Filter to waste after backwashing.
    b) Filter to waste after backwashing in conjunction with adding a polymer to the backwash water during the latter stages of backwashing.
    c) Continue to evaluate the use of a filter aid on a continuous basis.
    d) Continue to experiment with varying backwash flows and durations.
    e) Consider the use of slow opening valves on filter backwash.
    f) Continue to carry out yearly filter inspections and chlorination of filter media.

3. To obtain accurate amounts of chlorine used for pre and post-chlorination the chlorine gas piping could be reworked and additional equipment installed to allow weighing the chlorine used for pre and post-chlorination separately. The cost of the work would be approximately $5,000.00.

4. At the present time the chlorine residual of the water entering the clearwell is not determined. To obtain a sample for testing would require tapping the clearwell inlet pipe in the valve chamber and installing a pump and piping to allow obtaining a sample at a convenient location at an estimate cost of $2,000.00.

5. Implement a flowmeter calibration program.

F.2 Long Term Modifications

1. **Clarifier sludge sampling** is presently a two man task since plant staff must enter a confined space to obtain samples. An improved sampling system would reduce manpower requirements, eliminate a potentially dangerous task and would probably result in more frequent sampling and testing.

   The sample piping could be extended from the clarifier blow-down chambers to the basement under the microstrainers. This would involve difficult excavation in confined areas with interfering underground piping, especially for Clarifier No.2. Consideration could be given to using a sonic or photo-electric unit to indicate sludge blanket level.

2. **Streaming current meters** could be installed to optimize coagulant dosages. There might be some difficulty in arranging for suitable coagulant feed and streaming current meter sampling locations to ensure a properly mixed sample is obtained. If only minor piping modifications are required the work would cost approximately $25,000.00. It is recommended that use of this equipment be considered for the future to allow for more detailed assessment of its value at this plant and in the waterworks industry generally.

3. Upgrading of flow measuring and recording system should be undertaken in future plant expansion to replace existing obselete equipment.

4. Consideration should be given in future plant expansion to incorporate a Distributed Programmable Logic Control System to provide automatic process control, alarms, operator interface, automatic data collection, storage, display, trending and generation of hardcopy reports.

5. Consideration should be given to covering the clarifiers to:

   - Eliminate wind induced currents which affect clarifier performance.
   - Eliminate or reduce the formation of ice.

- Provide protection from airborne contaminants.
- Allow easier maintenance, cleaning and painting of mechanisms during off peak seasons when weather conditions prevent such work in the open.

6. Improvements should be made to eliminate the "bottleneck" in the filter inlet/outlet piping that restricts filtration rate.

7. Provide instrumentation for continuous analysis of plant effluent chlorine residual and turbidity.

8. Rectify problem of deficient post-chlorination contact time.

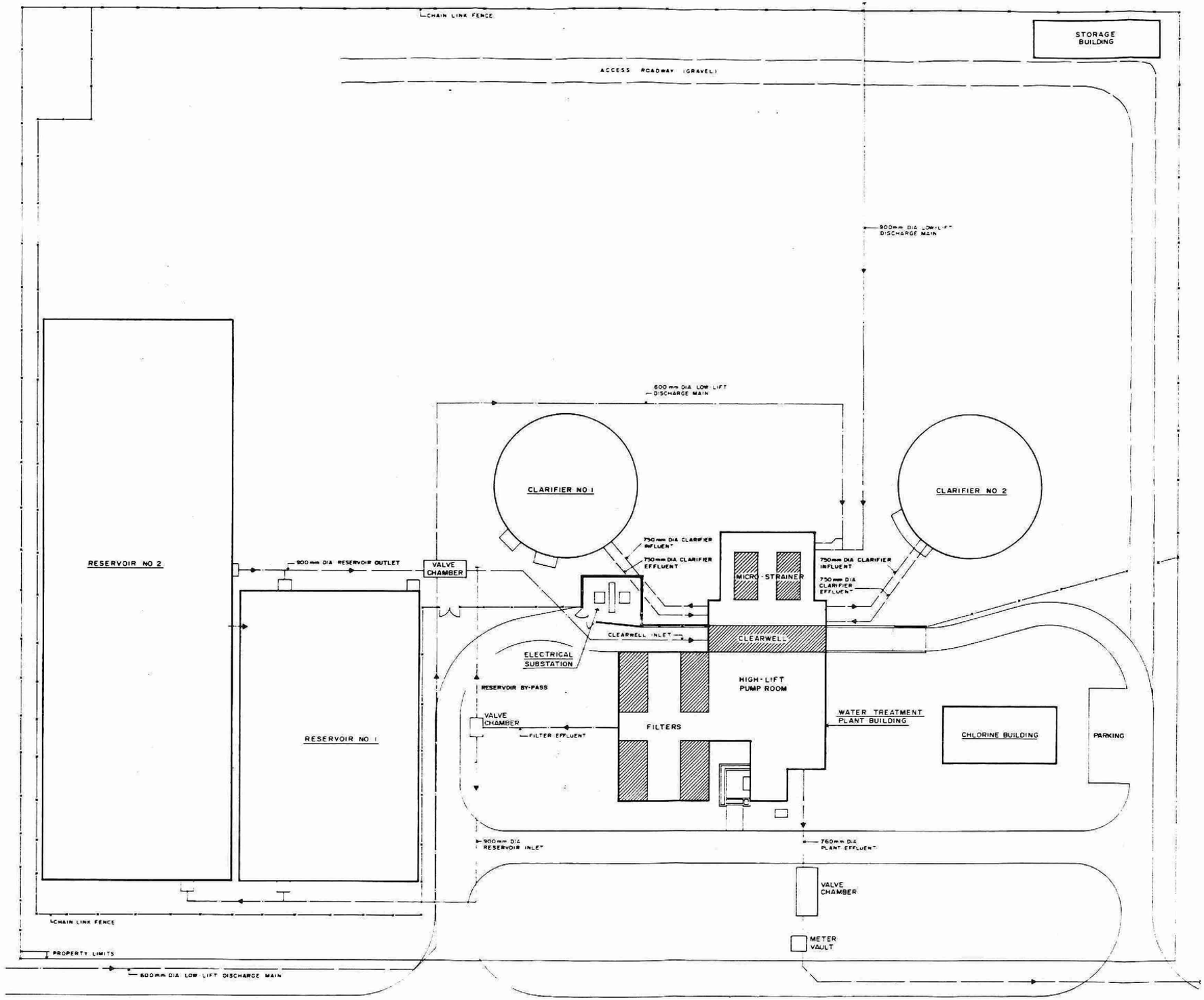
9. Carry out sieve analyses regularly to determine the extent (if any) of media degradation.

APPENDIX A
DRAWINGS

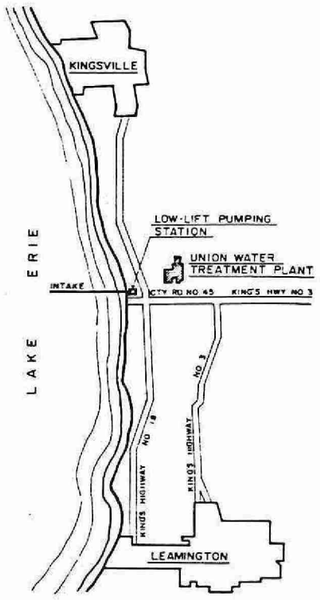
Figure 3 - Site Plan

Figure 4 - Block Schematic

Figure 5 - Process Flow Diagram (3 sheets)



SITE PLAN



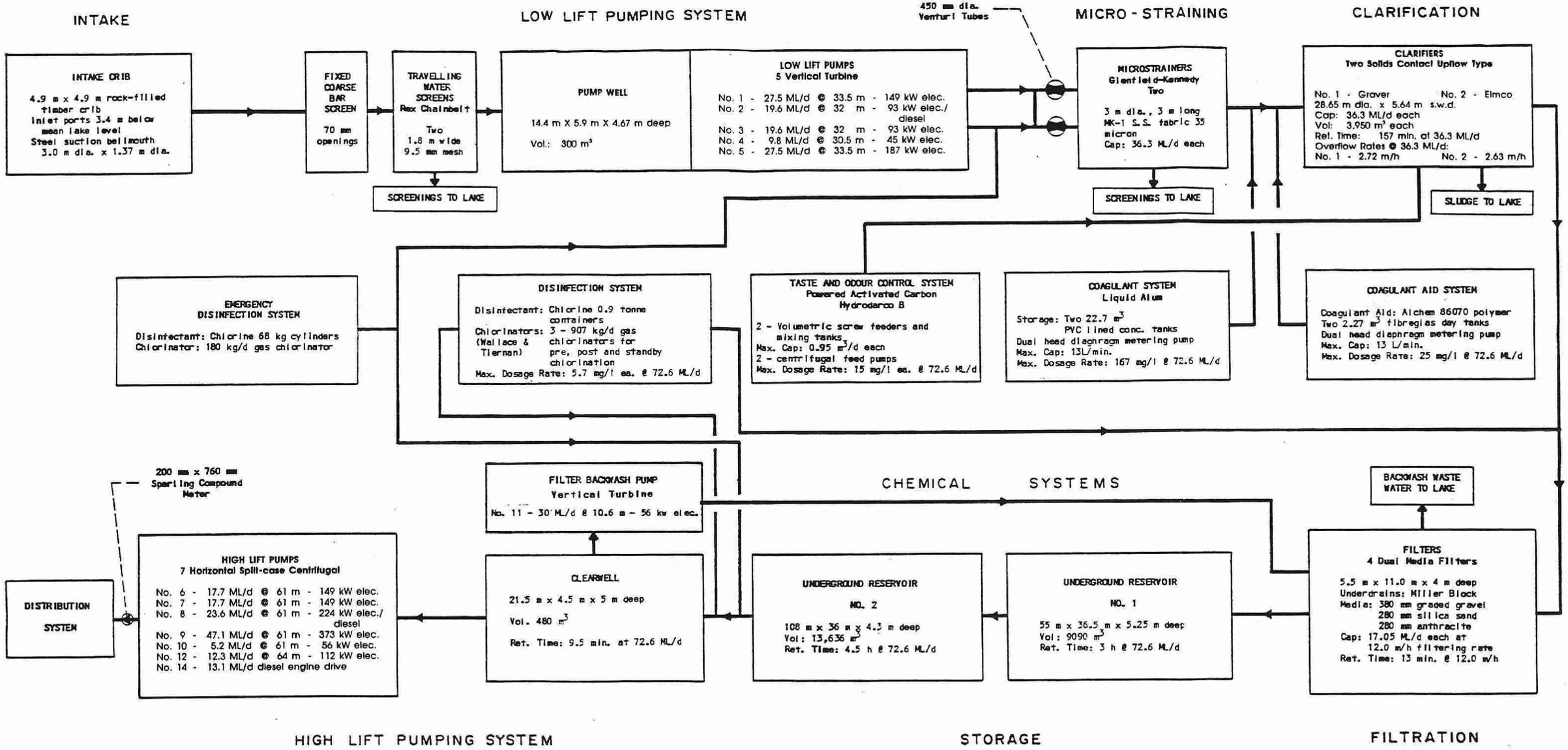
LOCATION PLAN

WATER PLANT OPTIMIZATION STUDY
MOE PROJECT NO. 7-2025
UNION WATER SYSTEM
SITE AND LOCATION PLANS

FIGURE 3

WR-158 1986-12-15

LaFONTAINE, COWIE, BURATTO & ASSOCIATES LIMITED
Consulting Engineers
3260 Devon Drive, Windsor, Ontario N8X 4L4

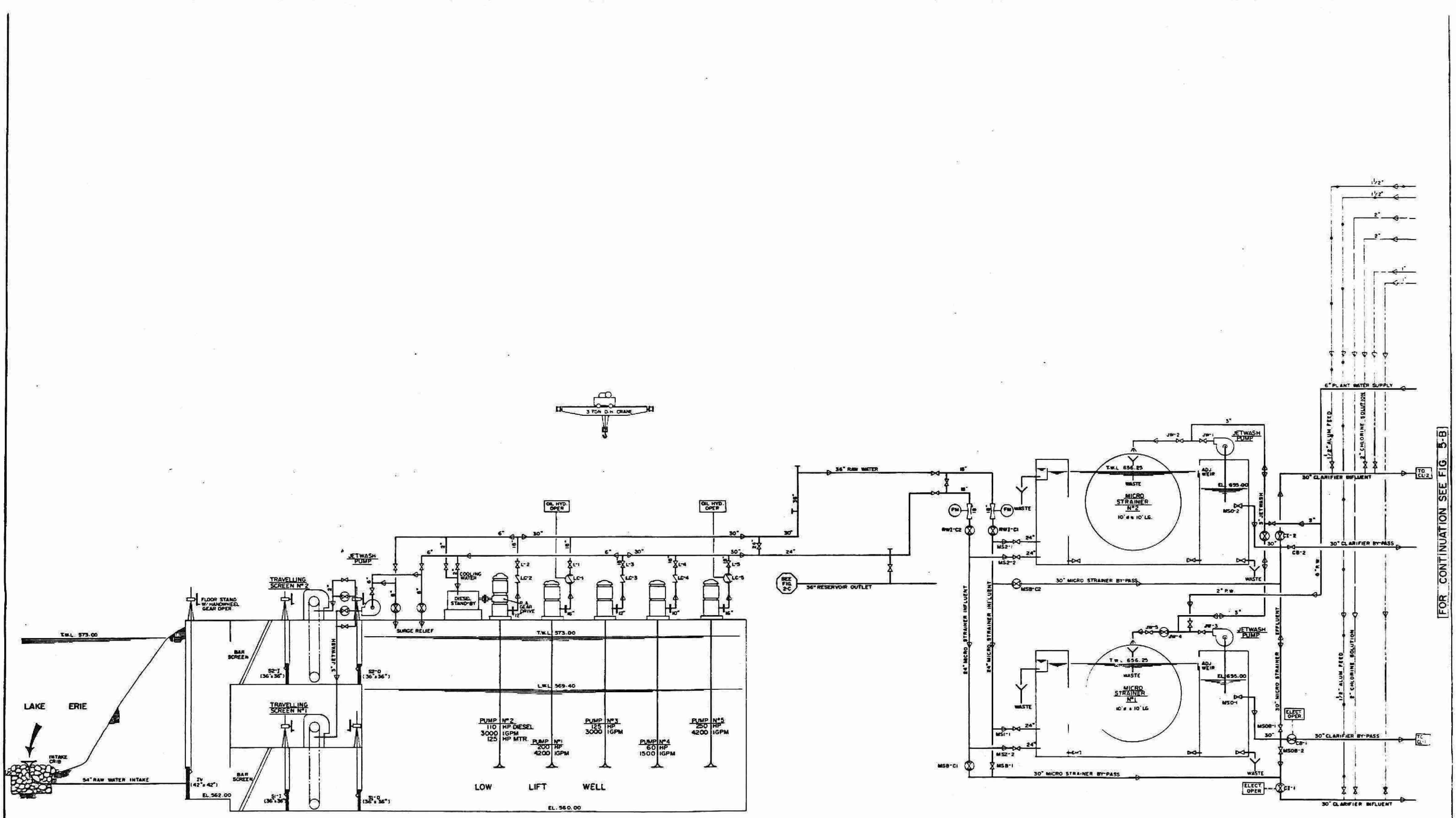


WATER PLANT OPTIMIZATION STUDY
M.O.E. PROJECT No. 7-2025
UNION WATER SYSTEM – BLOCK SCHEMATIC

FIGURE 4

LA FONTAINE, COWIE, BURATTO & ASSOCIATES LIMITED
Consulting Engineers
3260 Devon Drive, Windsor, Ontario N8X 4L4

1986·12·15
WP 158 - U



LEGEND (SHEETS 1 TO 3)

- EXISTING FACILITIES
- FUTURE FACILITIES
- EXISTING PROCESS WATER PIPING
- FUTURE PROCESS WATER PIPING
- CHLORINE SOLUTION PIPING
- ALUM FEED PIPING
- SILICA FEED PIPING
- CARBON FEED PIPING
- MANUALLY OPERATED SHUT-OFF VALVE
- PNEUMATIC AIR OPERATED SHUT-OFF VALVE (UNLESS NOTED OTHERWISE)
- MANUAL CHECK VALVE
- AUTOMATIC CHECK VALVE (AS INDICATED)
- FM FLOW MEASURING ELEMENT
- SLUICE GATE

WR 158 1986-12-15

ONTARIO MINISTRY OF THE ENVIRONMENT

WATER PLANT OPTIMIZATION STUDY

M.O.E. PROJECT No. 7-2025

UNION WATER SYSTEM · PROCESS FLOW DIAGRAM

LA FONTAINE, COWIE, BURATTO & ASSOCIATES LIMITED
Consulting Engineers
Windsor, Ontario

FIGURE 5-A

FOR CONTINUATION SEE FIG. 5-A

FOR CONTINUATION SEE FIG. 5-C

ALUM STORAGE
TANK N°2 5000 IMP GAL.
TANK N°1 5000 IMP GAL.
ALUM FEED PUMP 17.3 IGPH
1½" ALUM FEED (CL'FR. N°2 INFLUENT)
1½" ALUM FEED (CL'FR. N°1 INFLUENT)
2" CHLORINE SOLUTION (CL'FR. N°1 INFLUENT)
2" CHLORINE SOLUTION (CL'FR. N°1 EFFLUENT)
2" CHLORINE SOLUTION (CL'FR. N°2 INFLUENT)
2" CHLORINE SOLUTION (CL'FR. N°2 EFFLUENT)
ROTAMETERS
INJECTOR
INJECTOR
1 TON CYLINDER
1 TON CYLINDER
WEIGH SCALE
PRE
STAND-BY
POST
100 LB/DAY
250 LB/DAY
150 LB/DAY
CHLORINATORS 2000 LB/DAY MAX.
1 TON CYLINDER
1 TON CYLINDER
WEIGH SCALE
2.5 TON O.H. CRANE
DRY CHEMICAL HOPPER & FEEDER
MIXER
SOLUTION TANK
CARBON FEED PUMP 16.7 IGPM
DRY CHEMICAL BUCKET ELEVATOR
DRY CHEMICAL HOPPER & FEEDER
MIXER
SOLUTION TANK
CARBON FEED PUMP 16.7 IGPM
CARBON BAG STORAGE
POLYMER PUMP 17.3 IGPH
SAMPLE CONN.
MIXER
MIX & STORAGE TANK
POLYMER 500 IMP GAL
MIXER
POLYMER 500 IMP GAL
1" POLYMER FEED (CL'FR. N°2 INFLUENT)
1" POLYMER FEED (CL'FR. N°1 INFLUENT)
2" CARBON FEED (CLARIFIER N°1 & 2)
2" CARBON FEED (CLARIFIER N°1 & 2)
2" CHLORINE SOLUTION (PLANT EFFLUENT)
6" JET WASH WATER SUPPLY
16" MAIN WASH WATER SUPPLY
16" MAIN WASH WATER SUPPLY
6" PLANT WATER SUPPLY
6" JET WASH WATER SUPPLY
OVERFLOW EL. 652.83
T.W.L. 653.33
EFF. EL. 652.33
30" CLARIFIER INFLUENT
10" DRAIN
CLARIFIER N°2 (EIMCO)
9'4" d x 10' SWD
6" BLOW-DOWN
4" CLARIFIER BACKWASH
WASTE
30" CLARIFIER BY-PASS
CLARIFIER EFFLUENT
CHLORINE SOLUTION
6" PLANT WATER SUPPLY
OVERFLOW EL. 652.83
T.W.L. 653.33
EFF. EL. 652.33
30" CLARIFIER INFLUENT
10" DRAIN
CLARIFIER N°1 (GRAVER)
9'4" d x 10' SWD
6" BLOW-DOWN
4" CLARIFIER BACKWASH
WASTE
30" CLARIFIER BY-PASS
CLARIFIER EFFLUENT
CHLORINE SOLUTION
16" MAIN WASH WATER SUPPLY
16" FILTER BY-PASS
FJW-2A
FJW-2B
AIR CYLINDER OPER.
T.W.L. EL. 650.00
FILTER 2A 18' x 18'
FILTER 2B 18' x 18'
WASH TROUGH
FD-2A
FD-2B
FD-2 (18' x 18')
FOD-C2
FRW-2A
FRW-2B
12" FILTER EFFLUENT
FD-2
FD-C2
FMW-2A
FMW-2B
WASTE
16" MAIN WASH WATER SUPPLY
30" FILTER INFLUENT
30" FILTER BY-PASS
FJW-1A
FJW-1B
AIR CYLINDER OPER.
T.W.L. EL. 650.00
FILTER 1A 18' x 18'
FILTER 1B 18' x 18'
WASH TROUGH
FD-1A
FD-1B
FZ-1 (18' x 18')
FOD-C1
FRW-1A
FRW-1B
12" FILTER EFFLUENT
FD-1
FD-C1
FMW-1A
FMW-1B
16" MAIN WASH WATER SUPPLY
WASTE
30" FILTER INFLUENT
30" FILTER BY-PASS
INFLUENT CHANNELS ARE INTERCONNECTED W/O VALVE
FJW-4A
FJW-4B
T.W.L. EL. 650.00
EL. 650.75
FILTER 4A 18' x 18'
FILTER 4B 18' x 18'
WASH TROUGH
FD-4A
FD-4B
FZ-4 (18' x 18')
FOD-C4
FRW-4A
FRW-4B
12" FILTER EFFLUENT
FD-4
FD-C4
FMW-4A
FMW-4B
WASTE
16" MAIN WASH WATER SUPPLY
18" OVERFLOW
FJW-3A
FJW-3B
AIR CYLINDER OPER.
T.W.L. EL. 650.00
EL. 650.75
FILTER 3A 18' x 18'
FILTER 3B 18' x 18'
WASH TROUGH
FD-3A
FD-3B
FZ-3 (18' x 18')
FOD-C3
FRW-3A
FRW-3B
12" FILTER EFFLUENT
FD-3
FD-C3
FMW-3A
FMW-3B
WASTE
18" OVERFLOW
12" FILTER EFFLUENT
30" FILTER EFFLUENT
36" FILTER EFFLUENT
TO RESERVOIR
36"

FILTERS
MILLER BLOCK UNDERDRAINS
15" GRADED GRAVEL
12" SAND
12" ANTHRACITE

WR 158 1986-12-15

ONTARIO MINISTRY OF THE ENVIRONMENT

WATER PLANT OPTIMIZATION STUDY
M.O.E. PROJECT No. 7-2025
UNION WATER SYSTEM - PROCESS FLOW DIAGRAM

LA FONTAINE, COWIE, BURATTO & ASSOCIATES LIMITED
Consulting Engineers
Windsor, Ontario

FIGURE 5-B

FOR CONTINUATION SEE FIG. 5-B

LEAMINGTON ELEVATED WATER TOWER
330,000 IMP GALLONS
T.W.L. 818.00
L.W.L. 788.00

6" BY-PASS
LET-1
TO TOWNS OF COTTAM & ESSEX
12"
30"
TO TOWN OF LEAMINGTON
30"
TO TOWNS OF KINGSVILLE COTTAM & ESSEX
24"
30"
5 TON O.H. CRANE
VACUUM PUMP & TANK
ELECT. OPER.
6" PRESS. RELIEF
FR
D-1
D-2
12"
TO UNION DISTRIBUTION SYSTEM @ HWY. N° 18
6" VACUUM & AIR RELEASE
WASTE
METER CHAMBER

2" CHLORINE SOLUTION
6" JET WASH WATER SUPPLY
16" MAIN WASH WATER SUPPLY
16" MAIN WASH WATER SUPPLY
6" PLANT WATER SUPPLY

MW-1
MW-2
MW-C1
MW-3
JW-C1
JW-3
FM
12" EMERGENCY BACKWASH
PRESS REDUCING VALVE
6"
30"
30"
PLANT EFFLUENT
H-8
H-6
H-9
H-7
H-10
VACUUM PRIMING SYSTEM
6" PRESSURE RELIEF
DIESEL STAND-BY
HS-11
HS-8
HS-6
HS-9
HS-7
HS-10
HS-14
HS-13
HS-12

STORAGE RESERVOIR N°2
3 MILLION
IMPERIAL GALLONS
T.W.L. EL. 628.25

STORAGE RESERESERVOIR N°1
2 MILLION
IMPERIAL GALLONS
T.W.L. EL. 628.25

36"
36" FILTER EFFLUENT
36" RESERVOIR OUTLET
36"
36" RESERVOIR BY-PASS
D-3
36"
24" LOW LIFT MAIN
SEE FIG. 2-A

T.W.L. EL. 638.25

PUMP N°11 (WASH WATER)	PUMP N° 8	PUMP N°6	PUMP N°9	PUMP N°7	PUMP N°10	PUMP N°14	PUMP N°12
4580 IGPM	300 HP MTR. 3600 IGPM 300 HP DIESEL	150 HP 2700 IGPM	500 HP 7200 IGPM	200 HP 2700 IGPM	75 HP 800 IGPM	DIESEL ENGINE 2000 IGPM	1875 IGPM
	HIGH		LIFT		WELL		

L.W.L. EL. 624.00
VELOCITY BAFFLE
VELOCITY BAFFLE
EL. 622.00

WR 158 1986-12-15

ONTARIO MINISTRY OF THE ENVIRONMENT

WATER PLANT OPTIMIZATION STUDY
M.O.E. PROJECT No. 7-2025
UNION WATER SYSTEM - PROCESS FLOW DIAGRAM

LA FONTAINE, COWIE, BURATTO & ASSOCIATES LIMITED
Consulting Engineers
Windsor, Ontario

FIGURE 5-C

APPENDIX B
PLANT LOG SHEETS

1. Daily Summary
2. Operators Data Input Sheets
3. Operators Log
4. Laboratory Report
5. Chemical Usage

UNION WATER SYSTEM - DAILY SUMMARY

Time	Tank Level	Pres.	Clear Well	High Lift Flow	High Lift Pumps	Low Lift Pumps	No.1 Filter Flow	Loss of Head	No.2 Filter Flow	Loss of Head	No.3 Filter Flow	Loss of Head	No.4 Filter Flow	Loss of Head	Kings Tank
Shift No.1 Operator: _____ Coag: _____ _____ Polymer: _____ H2O Temp. _____ Chlorine:_____															
00:30															
01:00															
01:30															
02:00															
02:30															
03:00															
03:30															
04:00															
04:30															
05:00															
05:30															
06:00															
06:30															
07:00															
07:30															
08:00															
						Filter Runs:		Hours		Hours		Hours		Hours	
Shift No.2 Operator: _____ Coag: _____ _____ Polymer: _____ H2O Temp. _____ Chlorine:_____															
09:00															
09:30															
10:00															
10:30															
11:00															
11:30															
12:00															
12:30															
13:00															
13:30															
14:00															
14:30															
15:00															
15:30															
16:00															
						Filter Runs:		Hours		Hours		Hours		Hours	
Shift No.3 Operator: _____ Coag: _____ _____ Polymer: _____ H2O Temp. _____ Chlorine:_____															
16:30															
17:00															
17:30															
18:00															
18:30															
19:00															
19:30															
20:00															
20:30															
21:00															
21:30															
22:00															
22:30															
23:00															
23:30															
24:00															
Day:		Date:				Filter Runs:		Hours		Hours		Hours		Hours	

ONTARIO MINISTRY OF THE ENVIRONMENT
UNION WATER SYSTEM

Operators Data Input Sheet

Period: From _____ To _____

	Sun.	Mon.	Tues.	Wed.	Thurs	Fri.	Sat.
DATE							
RAW WATER							
temperature							
raw flow(mgd)							
raw avg. turb.							
CLARIFIERS							
clar. #1-avg. turb.							
clar. #2-avg. turb.							
FILTERS							
# filters in use							
avg. filt. run(hrs)							
backwash usage(mgd)							
avg. filt. effluent turb.							
TREATED WATER							
treated flow(mgd)							
max. hr. rate(gpm)							
treated avg. turb.							
max. treated turb.							
CHEMICALS							
alum used(gals)							
carbon dosage(ppm)							
polymer # of batches							
chlorine used(lbs.)							
pre-residual(ppm)							
post-residual(ppm)							
post-max. residual(ppm)							
post-min. residual(ppm)							

REMARKS:

OPERATERS LOG Date: _____

Weather: _____

Temperature

High: _____ Low: _____ Present: _____

Precipitation: _____

Wind: _____ Lake: _____

Number 1 Meter Reading

Present: _____

Previous: _____

H.L. Flow: _____

OPERATERS LOG Date: _____

Weather: _____

Temperature

High: _____ Low: _____ Present: _____

Precipitation: _____

Wind: _____ Lake: _____

Number 1 Meter Reading

Present: _____

Previous: _____

H.L. Flow: _____

OPERATERS LOG Date: _____

Weather: _____

Temperature

High: _____ Low: _____ Present: _____

Precipitation: _____

Wind: _____ Lake: _____

Number 1 Meter Reading

Present: _____

Previous: _____

H.L. Flow: _____

UNION WATER SYSTEM — Laboratory Report

Time	Cl 2 (mg/l)		Turbidity (NTU)									pH		L.L. Flow (GPM)
	Pre	Post	Raw	Clar 1	Clar 2	Filt 1	Filt 2	Filt 3	Filt 4	C.Filt	Syst	Raw	Sys	
	Oper. _____				Shift No: 1 00:01 - 08:00									
00:01														
01:00														
02:00														
03:00														
04:00														
05:00														
06:00														
07:00														
	Oper. _____				Shift No: 2 08:00 - 16:00									
08:00														
09:00														
10:00														
11:00														
12:00														
13:00														
14:00														
	Oper. _____				Shift No: 3 16:00 - 24:00									
16:00														
17:00														
18:00														
19:00														
20:00														
21:00														
22:00														
23:00														

Clarifier No.1 - Sludge Samples

Time	# 1	# 2	# 3	# 4	Flow	Depth

Clarifier No.2 - Sludge Samples

# 1	# 2	# 3	# 4	# 5	Flow	Depth

Day: _____ Date: _____

Comments:

CHEMICAL USAGE

****

NORTH TANK - 810 GAL/FT.
SOUTH TANK - 786 GAL/FT.

SHIFT 1 00:00 - 08:00
2 08:00 - 16:00
3 16:00 - 24:00

Date: _______________

1		2		3	
Raw	ALUM	Raw	ALUM	Raw	ALUM
Pres _________	Prev _________	Pres _________	Prev _________	Pres _________	Prev _________
Prev _________	Pres _________	Prev _________	Pres _________	Prev _________	Pres _________
Use _________	Use _________	Use _________	Use _________	Use _________	Use _________
SHIFT DOSE:		SHIFT DOSE:		SHIFT DOSE:	
	ALUM: _________ mg/l		ALUM: _________ mg/l		ALUM: _________ m

DAILY CHEMICAL USE:
Raw
Flow: _________ ALUM USED: _________ gals. ALUM DOSAGE RATE: _________ mg/l

Date: _______________

1		2		3	
Raw	ALUM	Raw	ALUM	Raw	ALUM
Pres _________	Prev _________	Pres _________	Prev _________	Pres _________	Prev _________
Prev _________	Pres _________	Prev _________	Pres _________	Prev _________	Pres _________
Use _________	Use _________	Use _________	Use _________	Use _________	Use _________
SHIFT DOSE:		SHIFT DOSE:		SHIFT DOSE:	
	ALUM: _________ mg/l		ALUM: _________ mg/l		ALUM: _________ m

DAILY CHEMICAL USE:
Raw
Flow: _________ ALUM USED: _________ gals. ALUM DOSAGE RATE: _________ mg/l

Date: _______________

1		2		3	
Raw	ALUM	Raw	ALUM	Raw	ALUM
Pres _________	Prev _________	Pres _________	Prev _________	Pres _________	Prev _________
Prev _________	Pres _________	Prev _________	Pres _________	Prev _________	Pres _________
Use _________	Use _________	Use _________	Use _________	Use _________	Use _________
SHIFT DOSE:		SHIFT DOSE:		SHIFT DOSE:	
	ALUM: _________ mg/l		ALUM: _________ mg/l		ALUM: _________ m

DAILY CHEMICAL USE:
Raw
Flow: _________ ALUM USED: _________ gals. ALUM DOSAGE RATE: _________ mg/l

Date: _______________

1		2		3	
Raw	ALUM	Raw	ALUM	Raw	ALUM
Pres _________	Prev _________	Pres _________	Prev _________	Pres _________	Prev _________
Prev _________	Pres _________	Prev _________	Pres _________	Prev _________	Pres _________
Use _________	Use _________	Use _________	Use _________	Use _________	Use _________
SHIFT DOSE:		SHIFT DOSE:		SHIFT DOSE:	
	ALUM: _________ mg/l		ALUM: _________ mg/l		ALUM: _________ r

DAILY CHEMICAL USE:
Raw
Flow: _________ ALUM USED: _________ gals. ALUM DOSAGE RATE: _________ mg/l

Alum: gals.used X 0.64 / raw water (millions of gals.) = mg/l (dosage)

APPENDIX C
DATA TABLES

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 1.0: FLOWS (ML/d)

		1986			1985			1984			1983		
		MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JAN	R	27.6	19.3	22.9	25.8	13.1	20.6	27.6	19.4	23.3			
	T	28.8	15.9	24.2	26.8	15.6	22.5	30.4	16.9	25.1			
FEB	R	29.6	19.2	22.5	26.8	20.1	22.1	26.9	12.8	21.8			
	T	28.1	16.9	23.6	30.0	16.9	23.7	28.0	16.7	23.5			
MAR	R	28.0	19.1	22.4	28.5	11.4	21.7	28.4	14.8	22.1			
	T	30.8	17.7	24.1	29.3	16.7	23.2	29.6	17.0	24.1			
APR	R	38.0	19.3	26.4	36.8	17.1	25.4	27.3	13.0	21.0			
	T	36.1	19.2	28.2	41.1	17.5	27.5	28.1	16.5	23.6			
MAY	R	42.8	20.6	33.3	44.3	20.5	33.7	33.0	15.2	26.1			
	T	43.6	22.0	35.3	46.6	23.6	36.2	35.8	19.2	29.0			
JUN	R	38.3	20.6	31.3	49.1	15.9	32.2	50.0	20.7	34.6			
	T	42.1	19.6	33.5	52.7	18.4	34.8	51.9	22.0	36.9			
JUL	R	55.8	21.1	40.7	58.8	21.7	41.0	68.3	24.9	45.9			
	T	57.3	25.9	43.1	58.8	23.2	43.5	67.1	26.5	47.7			
AUG	R				61.6	21.2	42.9	56.0	21.1	42.2	53.1	20.2	38.8
	T				61.6	22.1	45.1	58.6	22.5	43.8	57.0	22.0	40.8
SEP	R				63.4	23.2	43.2	55.0	19.0	42.0	57.1	16.8	41.9
	T				60.8	24.8	45.6	55.5	23.5	44.4	56.1	19.9	44.0
OCT	R				42.6	15.1	28.5	44.1	14.4	28.9	37.0	17.9	27.4
	T				45.1	17.8	30.8	46.5	17.5	30.7	38.5	17.6	29.1
NOV	R				31.6	12.7	23.5	29.4	12.5	23.3	31.3	13.8	23.5
	T				31.0	16.6	25.6	31.3	16.9	25.8	31.0	17.6	25.5
DEC	R				27.7	12.0	19.8	22.9	9.3	16.9	28.9	11.3	20.8
	T				28.3	17.0	21.1	25.1	15.4	19.1	29.0	15.0	22.2

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 1.1: DAILY FLOWS (ML/d) 1983

DAY	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC		DAY
	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	
MON															21.50	26.00									MON
TUE															35.60	36.70					25.60	31.00			TUE
WED															38.50	39.70					31.30	29.70			WED
THU															31.00	34.60	45.80	49.30			26.70	29.10	21.50	26.30	THU
FRI															34.20	34.30	51.50	56.10			26.70	28.40	25.90	25.90	FRI
SAT															27.50	29.00	50.40	52.70	29.00	27.40	21.20	21.00	19.20	20.10	SAT
SUN															22.20	24.90	32.20	35.40	18.80	22.50	18.80	17.60	11.30	16.50	SUN
MON															37.50	36.60	49.60	54.80	33.40	35.60	22.50	26.50	23.20	29.00	MON
TUE															39.00	43.00	57.10	54.60	34.20	38.50	24.50	26.70	28.90	28.00	TUE
WED															37.10	37.10	46.20	48.10	32.50	33.70	27.10	30.10	26.60	27.90	WED
THU															28.50	30.20	47.20	50.10	37.00	35.80	26.80	26.50	24.20	27.10	THU
FRI															31.40	33.90	50.00	54.60	32.20	34.60	21.80	19.80	20.50	27.30	FRI
SAT															30.50	29.00	48.80	52.40	21.00	21.00	18.90	18.90	22.60	19.90	SAT
SUN															20.20	22.00	34.40	34.40	18.60	18.90	13.80	18.90	17.50	17.20	SUN
MON															36.50	38.80	46.30	47.80	17.90	20.40	30.00	30.50	20.80	24.90	MON
TUE															43.40	45.30	49.90	53.70	31.50	33.30	25.70	29.30	19.40	25.50	TUE
WED															44.60	46.50	48.90	51.50	33.20	35.00	25.50	28.60	26.70	26.50	WED
THU															44.10	48.80	49.20	52.00	32.00	33.50	27.80	29.70	19.60	23.80	THU
FRI															49.10	49.00	44.00	41.50	29.80	33.50	27.90	29.00	22.30	22.30	FRI
SAT															45.90	49.20	33.90	32.60	20.60	22.60	17.60	19.10	17.10	17.20	SAT
SUN															34.10	31.80	16.80	19.90	18.10	19.70	14.50	17.80	19.30	15.00	SUN
MON															40.90	44.30	41.40	43.60	34.50	34.40	19.40	26.00	20.70	17.50	MON
TUE															52.50	57.00	43.90	45.40	30.50	34.60	24.70	26.50	19.10	16.60	TUE
WED															52.00	54.70	40.70	43.00	33.30	35.30	24.10	25.90	19.20	18.30	WED
THU															53.10	57.00	40.00	39.30	30.00	31.90	27.30	29.10	19.60	18.30	THU
FRI															46.50	52.10	42.70	44.30	28.50	33.10	21.80	26.50	19.30	20.30	FRI
SAT															48.40	48.10	35.00	36.60	21.30	20.30	20.00	20.30	19.20	22.50	SAT
SUN															30.20	35.00	18.80	22.90	18.80	17.60	19.90	18.70	19.20	21.10	SUN
MON															50.20	52.10	38.80	39.30	25.80	30.80	19.20	26.80	19.20	23.00	MON
TUE															52.20	53.10	39.80	41.90	30.90	31.00	28.40	29.20	19.40	24.00	TUE
WED															43.40	44.20	32.80	39.60	26.40	31.80	25.80	26.40	22.40	22.10	WED
THU																	42.00	40.70	30.00	31.20			19.90	20.20	THU
FRI																	38.20	43.30	27.30	31.00			19.10	19.70	FRI
SAT																			25.00	22.00			21.50	23.10	SAT
SUN																			18.00	19.30					SUN
MON																			28.80	30.60					MON
TUE																									TUE

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 1.1: DAILY FLOWS (ML/d) 1984

DAY	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC		DAY
	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	
MON																			40.23	40.55					MON
TUE									25.50	27.90									42.00	45.86					TUE
WED			23.20	27.20					24.40	30.00					56.00	58.60			42.55	45.05					WED
THU			24.90	26.60	28.40	29.60			25.90	28.70					48.10	48.60			44.14	46.50	26.77	30.54			THU
FRI			23.00	26.30	24.90	27.70			27.60	29.60	29.70	33.20			37.70	38.40			41.64	43.55	29.36	30.95			FRI
SAT			20.80	20.50	20.50	20.20			20.00	24.30	21.80	23.70			28.10	28.20	41.27	43.77	26.82	30.23	21.82	20.63	19.36	18.22	SAT
SUN	19.40	18.90	21.00	17.70	21.00	17.50	15.20	18.10	20.00	22.30	20.70	22.00	36.30	38.10	22.00	24.00	27.86	26.50	22.09	19.77	12.72	17.36	9.32	15.41	SUN
MON	19.40	21.30	22.70	24.50	21.90	23.50	21.40	24.30	30.80	32.20	32.90	36.10	42.50	45.10	33.20	33.50	44.41	47.55	14.36	19.72	25.41	31.14	19.41	23.54	MON
TUE	24.50	27.20	22.70	25.40	20.70	24.90	21.00	24.00	26.10	31.40	31.30	34.20	53.10	55.30	41.40	42.60	54.96	55.41	34.18	34.27	28.45	27.63	21.82	23.86	TUE
WED	27.50	28.00	21.40	24.50	24.90	27.00	25.60	27.00	26.70	30.20	31.60	32.60	43.90	48.10	38.10	38.90	50.55	53.96	31.77	37.41	26.09	30.09	19.45	23.91	WED
THU	23.30	27.80	22.80	24.60	24.40	26.40	22.90	24.20	30.90	33.00	32.20	34.90	34.70	36.70	41.70	45.10	54.77	54.60	37.27	37.23	28.68	28.82	22.86	25.14	THU
FRI	25.60	27.80	21.50	24.50	16.50	27.00	25.50	26.10	28.00	32.00	32.20	34.50	32.00	36.00	46.80	47.30	49.14	52.82	30.73	33.14	27.41	29.59	21.41	24.27	FRI
SAT	19.50	21.20	20.70	20.60	27.70	21.20	20.00	20.70	24.50	27.00	27.10	31.80	27.00	26.50	33.30	37.10	43.77	45.91	16.91	21.45	20.59	20.63	19.41	19.36	SAT
SUN	19.40	18.70	20.60	17.60	20.30	17.30	18.50	18.40	20.00	20.60	29.20	29.70	24.90	26.50	27.40	25.50	21.91	24.04	20.36	18.59	12.45	16.91	11.13	16.77	SUN
MON	23.80	26.30	22.70	24.40	20.50	26.60	22.70	28.10	27.40	31.70	41.60	42.80	36.70	39.80	35.80	37.70	45.65	45.91	28.59	30.64	15.54	20.50	19.13	22.41	MON
TUE	24.10	27.80	21.70	25.00	24.20	27.50	25.30	27.00	31.30	34.80	41.10	45.70	42.20	46.40	41.10	44.60	49.91	51.68	27.32	32.41	27.77	30.41	19.27	23.23	TUE
WED	27.60	28.50	21.30	25.40	24.40	26.60	24.60	27.50	33.00	35.80	43.50	42.90	44.10	44.70	49.20	50.40	45.86	49.50	30.82	32.73	29.13	30.77	19.59	22.95	WED
THU	25.50	28.50	26.90	27.90	22.00	25.50	24.70	28.00	32.40	34.70	33.40	35.90	50.40	51.90	52.70	55.00	47.18	50.27	28.59	31.54	27.27	30.59	19.41	23.00	THU
FRI	25.20	30.40	22.50	25.10	21.00	24.70	23.20	28.00	26.50	32.00	32.70	35.50	52.70	55.70	51.20	52.30	48.00	51.00	28.54	31.73	27.95	31.32	19.27	22.36	FRI
SAT	24.00	23.10	20.60	18.60	20.50	19.20	19.90	20.00	24.40	22.40	26.90	30.00	48.00	51.20	39.60	41.40	36.73	37.27	21.32	20.09	20.22	19.86	13.77	17.45	SAT
SUN	20.20	18.30	15.20	16.70	14.80	17.00	14.00	17.60	15.20	19.20	26.30	25.20	39.70	40.30	21.10	22.50	19.04	23.50	15.59	17.45	13.68	17.00	13.59	16.54	SUN
MON	24.60	27.70	20.00	24.50	20.40	25.70	20.50	25.30	20.40	22.20	34.50	36.70	49.90	53.10	37.60	38.30	42.92	47.64	26.54	24.95	25.09	28.77	16.50	17.95	MON
TUE	23.60	25.20	20.60	25.60	24.10	26.00	23.20	25.60	27.70	30.00	32.70	37.00	44.70	45.60	46.00	47.50	51.18	50.82	27.45	31.50	26.36	27.54	14.72	16.82	TUE
WED	24.80	28.20	24.30	23.80	23.50	25.60	23.70	26.40	25.60	30.00	38.20	39.10	40.10	43.20	46.60	49.90	48.73	54.00	28.50	31.23	21.22	26.36	15.72	16.36	WED
THU	24.40	26.50	23.80	25.70	20.50	25.10	21.70	25.40	29.40	33.00	40.30	44.40	52.40	56.70	51.80	53.10	53.73	55.46	28.32	30.86	28.18	28.59	13.91	17.00	THU
FRI	21.90	26.30	23.10	26.00	25.30	24.90	19.70	21.00	30.90	33.00	44.60	45.00	55.10	60.00	50.20	54.90	48.36	52.41	31.18	33.04	24.18	28.41	14.50	17.13	FRI
SAT	21.50	22.30	20.50	18.90	16.00	20.20	16.20	19.90	20.40	22.60	37.80	41.90	54.80	56.10	47.30	48.60	40.23	42.73	21.72	20.04	19.50	20.13	19.36	17.60	SAT
SUN	20.20	19.00	12.80	17.10	19.70	18.00	13.00	16.50	17.70	20.10	26.50	24.90	46.10	45.70	30.50	31.00	24.13	25.23	16.63	19.18	16.09	17.68	15.54	16.59	SUN
MON	24.60	27.00	24.20	25.80	20.70	25.70	14.50	18.50	27.10	30.70	36.10	38.50	56.80	59.80	50.40	51.30	41.95	42.05	25.45	30.73	22.68	26.50	12.68	17.60	MON
TUE	23.90	29.10	20.50	23.50	20.60	25.20	19.60	22.50	31.50	33.50	42.80	46.20	68.30	67.10	53.20	54.10	44.73	48.82	33.95	31.23	21.72	25.77	19.27	15.45	TUE
WED	25.20	28.30	25.40	28.00	25.00	28.90	27.30	28.00	27.20	31.60	35.60	37.00	66.60	64.70	49.70	52.60	46.14	47.68	29.95	30.41	23.95	27.00	12.27	16.04	WED
THU	24.20	28.10			24.60	25.10	24.30	27.00	31.80	35.00	46.60	50.60	51.60	50.50	50.00	52.70	43.23	46.86			23.41	26.09	19.22	17.13	THU
FRI	25.30	26.30			24.50	26.70	20.10	26.50			50.00	51.90	40.30	41.30	49.50	52.90	40.86	44.77			23.86	27.18	11.04	16.72	FRI
SAT	20.50	22.00			21.00	20.60	19.90	21.80			39.30	42.90	38.10	39.30			30.41	35.00					19.27	16.86	SAT
SUN	20.50	16.90					18.90	18.50					30.90	33.80			24.41	23.59					11.86	16.00	SUN
MON	23.00	25.00					23.30	27.00					55.70	56.40									19.36	17.86	MON
TUE	23.90	26.60											62.80	62.50											TUE

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 1.1: DAILY FLOWS (ML/d) 1985

DAY	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC		DAY
	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	
MON							27.3	25.0					35.2	36.5											MON
TUE	13.1	15.6					26.5	24.8					40.6	42.9					40.8	45.1					TUE
WED	19.5	24.3					23.4	24.9	31.5	33.0			33.9	40.9					41.7	44.4					WED
THU	25.8	26.2					23.4	25.7	27.9	33.4			45.7	44.6	48.0	48.7			37.1	42.1					THU
FRI	21.3	25.9	21.1	25.4	24.0	24.7	19.2	20.0	36.9	37.2			36.9	37.0	50.5	55.6			42.6	43.2	28.4	31.0			FRI
SAT	19.4	19.0	20.6	19.6	21.4	19.6	17.3	18.7	28.7	32.3	25.0	27.0	21.7	24.6	51.0	52.6			29.0	31.2	21.2	18.6			SAT
SUN	16.4	16.4	23.1	25.4	21.2	18.5	18.8	17.5	28.5	28.0	21.3	23.4	23.4	27.5	40.9	40.7	27.1	33.2	20.1	19.6	12.7	16.6	12.0	17.8	SUN
MON	19.3	23.5	24.0	26.5	21.4	22.2	17.1	19.9	29.6	31.7	28.6	30.9	45.1	48.1	38.2	38.5	51.8	53.6	28.9	34.1	25.1	27.0	23.6	26.7	MON
TUE	23.0	24.3	21.7	24.5	21.0	23.6	19.6	23.6	34.9	38.7	31.5	32.8	56.2	58.0	37.9	39.8	63.4	60.8	34.8	38.5	25.5	28.2	23.8	26.9	TUE
WED	20.0	23.3	23.5	24.9	21.1	25.1	23.9	25.1	35.3	39.3	32.9	37.6	39.8	42.6	40.1	42.0	54.0	57.9	30.5	34.6	25.4	28.2	22.3	27.2	WED
THU	22.0	23.4	23.3	24.8	24.1	24.9	24.0	25.5	41.7	46.2	36.9	42.2	40.1	44.4	49.2	51.9	53.2	55.8	30.9	32.3	25.5	30.6	27.7	25.9	THU
FRI	19.6	24.0	20.1	25.4	20.8	23.9	19.7	25.0	44.2	46.6	39.8	43.0	50.8	53.9	61.6	61.6	48.9	51.0	32.2	33.6	30.3	30.7	20.0	26.8	FRI
SAT	19.5	19.3	20.2	20.0	20.6	19.0	19.8	20.5	38.6	43.3	36.9	39.7	47.9	50.1	46.1	50.9	43.9	46.5	22.5	21.0	17.6	19.2	18.6	18.9	SAT
SUN	15.6	17.0	20.4	17.6	20.7	17.8	17.3	19.2	35.0	34.1	26.3	28.7	26.5	23.2	34.4	37.0	25.9	27.0	16.4	18.4	14.7	16.8	13.8	17.0	SUN
MON	20.2	24.0	20.5	24.5	20.8	22.2	26.1	30.3	38.6	43.9	44.0	45.9	29.5	33.2	52.1	52.6	43.8	45.1	16.1	20.0	16.1	18.9	25.4	28.3	MON
TUE	24.5	26.8	22.7	24.9	20.5	24.6	26.4	27.1	44.3	46.6	32.2	32.3	35.8	39.1	51.4	54.5	43.3	48.6	32.0	33.9	22.2	25.6	25.1	27.9	TUE
WED	19.5	23.7	25.0	24.8	21.0	22.0	24.7	29.6	35.7	37.2	30.0	31.3	36.5	39.5	46.6	46.9	48.3	49.3	29.6	33.6	26.1	29.9	23.1	24.7	WED
THU	22.8	23.4	20.2	24.0	21.1	23.3	31.0	31.8	36.3	37.5	27.1	30.8	41.1	45.1	45.1	46.8	46.2	48.3	32.5	33.6	28.4	29.3	19.4	23.2	THU
FRI	20.6	24.0	20.4	23.5	21.8	25.2	27.6	28.6	30.1	33.4	29.7	34.3	42.4	44.3	38.0	40.5	45.3	50.7	30.7	35.6	25.7	28.5	23.3	25.4	FRI
SAT	19.6	18.6	21.0	19.7	21.1	19.6	23.5	25.0	20.5	24.7	23.6	21.8	35.6	35.6	34.1	35.7	42.5	42.8	22.5	19.8	20.0	19.5	18.9	19.6	SAT
SUN	19.5	17.9	20.4	17.9	14.1	17.0	17.1	22.7	23.4	23.6	15.9	18.4	28.9	28.3	21.2	22.1	23.8	25.6	15.1	18.0	17.0	17.1	19.1	18.3	SUN
MON	21.6	23.1	20.5	23.8	22.5	24.8	32.0	34.0	26.0	26.8	26.7	29.7	42.0	45.4	36.1	38.7	47.1	48.5	25.7	31.7	25.8	30.0	15.3	19.5	MON
TUE	22.8	25.3	24.8	21.0	22.5	26.5	36.8	41.1	33.0	37.3	30.1	33.2	49.2	51.6	44.8	46.1	49.5	51.7	28.5	31.4	28.3	29.2	19.1	18.6	TUE
WED	22.0	24.0	20.3	24.6	25.4	27.4	36.2	37.9	34.7	36.5	27.8	31.9	49.7	54.8	45.6	48.1	50.6	52.9	31.1	32.5	22.7	28.4	18.9	18.0	WED
THU	22.2	24.5	26.8	27.0	28.5	29.2	33.5	37.6	36.0	39.2	33.4	35.1	51.1	56.7	47.1	49.4	49.1	52.6	32.7	31.4	28.2	29.7	19.1	18.4	THU
FRI	19.7	24.2	22.2	27.6	25.8	29.3	35.0	38.5	43.2	45.8	36.4	39.5	50.3	52.3	45.5	49.0	49.5	51.8	29.1	31.6	26.7	30.5	19.2	18.2	FRI
SAT	19.6	19.2	20.6	22.2	20.9	19.7	27.9	29.5	38.3	42.3	23.3	23.2	46.8	51.2	38.1	40.1	41.9	44.2	20.9	20.7	20.7	19.7	19.1	19.4	SAT
SUN	19.6	17.9	20.6	16.9	18.4	18.0	22.2	24.1	33.7	34.3	22.0	23.9	38.7	41.8	21.6	22.9	31.3	31.4	16.2	17.8	19.5	18.0	18.6	17.3	SUN
MON	23.7	25.0	20.7	23.7	22.8	27.6	31.5	35.0	33.4	36.0	35.8	38.6	58.8	58.8	39.3	42.5	40.5	42.5	23.3	29.4	23.8	28.2	19.5	19.0	MON
TUE	23.0	25.2	21.4	26.3	24.6	27.2	32.4	35.6	32.4	34.6	37.1	42.6	53.5	55.0	46.0	47.8	42.1	46.7	28.6	32.3	25.8	29.6	19.0	20.1	TUE
WED	22.3	25.8	25.6	27.4	25.3	24.9			33.7	35.8	44.2	45.7	38.5	40.5	45.3	48.6	47.1	47.6	34.7	32.3	28.9	29.1	18.6	17.2	WED
THU	20.4	23.4	26.5	30.0	25.5	28.3			31.3	32.8	44.6	46.7			46.9	50.7	44.6	48.0	26.8	30.3	21.7	30.3	18.6	17.5	THU
FRI					27.4	28.2			27.8	31.5	49.1	52.7			47.4	50.7	42.9	46.9			31.6	28.7	18.5	19.2	FRI
SAT					15.9	18.7					37.5	43.5			41.6	45.5	34.6	39.1			18.2	20.9	18.4	19.3	SAT
SUN					11.4	16.7					36.5	36.7					23.2	24.8					18.6	18.3	SUN
MON																	41.0	42.3					18.6	18.5	MON
TUE																							18.7	19.6	TUE

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 1.1: DAILY FLOWS (ML/d) 1986

DAY	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC		DAY
	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	
MON																									MON
TUE							25.9	29.0					27.0	30.1											TUE
WED	19.3	17.8					28.7	30.0					33.1	37.6											WED
THU	22.9	26.0					28.1	28.8	32.4	36.9			37.8	37.0											THU
FRI	22.9	27.6					27.5	27.2	36.6	35.9			38.3	44.2											FRI
SAT	19.6	18.1	20.8	19.2	20.6	21.1	20.6	21.0	29.3	29.4			42.7	45.8											SAT
SUN	20.1	17.1	20.5	17.0	19.1	18.4	19.3	19.2	21.7	25.1	26.2	26.3	39.2	41.6											SUN
MON	23.5	26.5	21.7	24.4	24.1	26.5	26.1	28.3	33.4	36.6	33.2	35.7	47.0	50.7											MON
TUE	24.0	26.5	24.1	25.4	25.3	26.3	26.7	28.7	36.6	39.6	35.4	38.9	44.2	42.7											TUE
WED	24.6	26.7	25.6	26.8	24.6	29.0	24.0	25.8	41.1	40.4	37.7	42.1	37.0	38.1											WED
THU	23.2	26.6	26.8	28.1	26.1	26.6	25.1	28.1	36.0	40.9	36.4	35.2	38.0	40.7											THU
FRI	19.6	27.9	22.2	26.3	19.2	24.9	25.1	28.4	37.5	39.1	28.6	33.9	33.1	36.1											FRI
SAT	23.8	20.6	20.7	19.6	19.3	20.3	19.9	23.6	32.1	37.5	23.9	25.0	31.0	25.9											SAT
SUN	19.7	17.3	20.5	17.3	19.3	17.7	19.6	19.5	33.7	31.9	23.6	22.8	21.1	24.4											SUN
MON	20.2	26.3	25.2	26.6	20.7	23.9	25.6	31.1	40.6	43.6	31.6	36.0	35.0	36.4											MON
TUE	25.5	26.2	23.8	26.1	20.8	23.9	29.6	28.5	42.8	42.6	33.2	34.2	38.3	42.0											TUE
WED	25.6	27.4	23.4	25.6	25.0	25.0	29.9	30.2	36.8	38.0	28.6	33.6	41.8	43.6											WED
THU	27.6	28.8	29.6	26.1	21.2	24.8	28.1	29.1	39.5	41.5	33.5	33.5	40.5	45.4											THU
FRI	24.0	28.2	20.1	26.9	21.7	24.7	26.6	30.0	36.1	36.1	33.6	36.7	52.2	53.1											FRI
SAT	20.3	20.2	19.4	19.3	19.4	20.1	25.5	26.1	28.6	30.5	26.6	25.8	43.2	46.7											SAT
SUN	20.1	16.9	19.2	16.9	19.4	17.8	20.1	20.3	22.7	22.4	20.7	19.6	31.0	33.9											SUN
MON	23.6	23.3	23.6	24.2	23.9	25.6	24.7	26.6	20.6	22.0	29.5	34.5	40.7	44.8											MON
TUE	21.2	24.6	22.8	24.6	24.9	28.2	26.0	29.8	28.3	32.6	33.6	36.1	50.2	53.6											TUE
WED	25.0	25.9	22.6	23.9	25.2	26.8	28.2	32.3	38.1	39.1	34.1	37.9	52.6	55.8											WED
THU	24.9	27.3	21.3	22.7	25.9	27.6	31.4	30.4	30.5	36.8	31.9	34.0	55.8	56.3											THU
FRI	22.3	27.2	19.3	25.6	25.3	30.8	26.9	31.1	36.0	34.6	33.0	36.8	46.2	45.8											FRI
SAT	21.0	18.5	19.3	19.1	22.7	22.6	24.9	24.8	28.7	29.8	25.9	26.9	37.3	36.8											SAT
SUN	20.5	15.9	19.4	16.9	19.4	19.1	22.4	30.4	20.7	22.5	20.6	23.2	27.8	28.3											SUN
MON	24.2	26.2	24.5	26.5	22.9	27.3	33.4	36.1	32.2	35.8	38.3	40.8	47.2	47.2											MON
TUE	27.1	28.2	23.6	25.1	28.0	28.0	38.0	36.0	34.3	35.6	37.2	40.0	46.7	50.5											TUE
WED	24.5	28.0	21.7	25.6	24.8	27.9	34.6	35.0	36.0	38.6	35.6	40.8	51.5	57.3											WED
THU	26.7	25.7	28.2	28.0	26.5	27.1			37.4	39.1	37.7	41.2	54.2	54.8											THU
FRI	23.8	26.4	20.7	28.1	19.5	23.7			35.2	41.2	37.8	37.9													FRI
SAT					19.3	21.4			36.1	35.8	29.1	35.6													SAT
SUN					19.8	19.6					30.9	30.0													SUN
MON					19.1	21.5					30.2	30.9													MON
TUE																									TUE

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 2.0: PARTICULATE REMOVAL SUMMARY

			1986			1985			1984			1983		
			MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JAN	Turbidity (FTU)	R	6.30	3.00	4.03	57.30	3.70	14.49	8.60	3.50	4.96			
		T	0.24	0.07	0.14	0.61	0.16	0.26	1.40	0.18	0.50			
	Prime Coagulant (mg/L)		* 5.37	* 4.07	* 4.85	31.50	14.00	18.42	20.90	11.70	14.94			
	Coagulant Aid (mg/L)		0.16	0.09	0.12	0.32	0.11	0.16	0.15	0.15	0.15			
	Metal Res. Al (mg/L)	R												
		T	0.08	0.07	0.08	0.06	0.03	0.04	0.03	0.02	0.03			
	pH	R												
		T												
	Temperature (Deg.C.)	R	0.50	0.50	0.50	2.00	0.50	0.70	0.50	0.50	0.50			
FEB	Turbidity (FTU)	R	4.80	1.20	2.24	12.80	1.60	3.31	58.90	3.10	6.65			
		T	0.18	0.07	0.11	0.90	0.14	0.30	0.66	0.20	0.31			
	Prime Coagulant (mg/L)		* 5.35	* 4.57	* 4.95	15.70	11.00	13.79	34.80	11.80	15.31			
	Coagulant Aid (mg/L)		0.10	0.10	0.10	0.26	0.10	0.14	0.25	0.15	0.16			
	Metal Res. Al (mg/L)	R												
		T	0.09	0.02	0.06	0.05	0.03	0.04	0.05	0.03	0.04			
	pH	R												
		T												
	Temperature (Deg.C.)	R	0.50	0.50	0.50	0.50	0.50	0.50	1.00	0.50	0.70			
MAR	Turbidity (FTU)	R	18.40	1.50	4.29	34.60	2.10	13.21	83.60	4.70	11.27			
		T	0.17	0.08	0.10	0.72	0.13	0.23	0.74	0.13	0.31			
	Prime Coagulant (mg/L)		* 7.10	* 4.64	* 5.29	27.20	13.30	19.67	38.40	12.10	18.89			
	Coagulant Aid (mg/L)		0.12	0.05	0.08	0.25	0.10	0.15	0.15	0.15	0.15			
	Metal Res. Al (mg/L)	R												
		T												
	pH	R	0.08	0.04	0.06	0.04	0.01	0.02	0.06	0.02	0.03			
		T												
	Temperature (Deg.C.)	R	1.00	0.50	0.60	4.80	0.50	1.30	1.00	0.50	0.80			

* INDICATES POLYALUMINUM CHLORIDE

TABLE 2.0: PARTICULATE REMOVAL SUMMARY

			1986			1985			1984			1983		
			MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
APR	Turbidity (FTU)	R	20.20	2.40	7.81	121.60	6.20	46.34	25.70	2.00	4.72			
		T	0.20	0.08	0.09	0.42	0.12	0.19	0.62	0.09	0.13			
	Prime Coagulant (mg/L)		26.80	16.50	20.63	78.00	18.80	32.17	29.00	15.60	20.54			
	Coagulant Aid (mg/L)		0.20	0.06	0.12	0.33	0.09	0.20	0.15	0.15	0.15			
	Metal Res. Al (mg/L)	R												
		T	0.13	0.04	0.09	0.03	0.02	0.03	0.05	0.02	0.03			
	pH	R												
		T												
	Temperature (Deg.C.)	R	11.50	1.50	6.30	13.50	3.50	7.00	10.50	2.50	5.40			
MAY	Turbidity (FTU)	R	10.30	2.70	5.23	22.10	4.00	8.91	59.40	2.70	14.72			
		T	0.15	0.08	0.11	0.35	0.10	0.14	0.22	0.07	0.10			
	Prime Coagulant (mg/L)		26.00	17.30	20.70	21.90	17.70	20.25	33.20	14.50	20.24			
	Coagulant Aid (mg/L)		0.18	0.07	0.13	0.22	0.07	0.15	0.25	0.15	0.16			
	Metal Res. Al (mg/L)	R												
		T	0.12	0.10	0.11	0.09	0.06	0.08	0.06	0.03	0.04			
	pH	R												
		T												
	Temperature (Deg.C.)	R	18.00	11.50	14.90	18.50	9.00	15.70	15.50	10.00	12.60			
JUN	Turbidity (FTU)	R	82.80	3.70	16.72	29.00	3.10	10.81	29.00	2.40	6.55			
		T	0.23	0.07	0.11	0.20	0.10	0.14	0.20	0.06	0.11			
	Prime Coagulant (mg/L)		36.50	17.50	21.83	24.40	17.90	20.29	24.10	18.90	20.20			
	Coagulant Aid (mg/L)		23.00	0.07	0.14	0.22	0.09	0.16	0.15	0.15	0.15			
	Metal Res. Al (mg/L)	R												
		T	0.12	0.06	0.09	0.09	0.07	0.08	0.09	0.05	0.07			
	pH	R	8.04	7.73	7.89									
		T	7.38	7.34	7.36									
	Temperature (Deg.C.)	R	22.50	17.50	20.10	22.00	18.50	20.00	23.00	15.00	20.60			

*

* INDICATES POLYALUMINUM CHLORIDE

TABLE 2.0: PARTICULATE REMOVAL SUMMARY

			1986			1985			1984			1983		
			MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JUL	Turbidity (FTU)	R	18.70	3.00	7.49	12.70	3.20	6.45	19.60	1.90	5.55			
		T	0.15	0.06	0.08	0.21	0.12	0.14	0.16	0.06	0.09			
	Prime Coagulant (mg/L)		22.20	18.40	20.53	21.50	14.50	19.00	20.90	13.50	18.54			
	Coagulant Aid (mg/L)		0.21	0.08	0.15	0.22	0.10	0.15	0.15	0.15	0.15			
	Metal Res. Al (mg/L)	R												
		T	0.14	0.09	0.11	0.21	0.06	0.12	0.10	0.07	0.08			
	pH	R	8.40	8.12	8.25									
		T	7.75	7.53	7.61									
	Temperature (Deg.C.)	R	27.50	21.50	24.10	25.50	21.80	24.20	24.00	21.00	22.60			
AUG	Turbidity (FTU)	R				16.20	1.70	4.59	12.00	1.40	3.75	38.40	2.40	5.60
		T				0.24	0.02	0.16	0.15	0.06	0.09	0.17	0.09	0.11
	Prime Coagulant (mg/L)					21.30	18.50	19.87	16.20	13.40	15.06	23.20	19.70	20.61
	Coagulant Aid (mg/L)					0.21	0.06	0.14	0.15	0.15	0.15	0.15	0.15	0.15
	Metal Res. Al (mg/L)	R												
		T				0.11	0.10	0.11	0.13	0.07	0.09	0.13	0.04	0.08
	pH	R												
		T												
	Temperature (Deg.C.)	R				25.60	23.00	24.00	25.50	23.00	24.40	25.00	24.00	24.70
SEP	Turbidity (FTU)	R				20.50	3.00	5.90	40.40	4.10	9.44	27.50	2.50	8.32
		T				0.22	0.10	0.14	0.15	0.09	0.10	0.15	0.09	0.11
	Prime Coagulant (mg/L)					23.00	18.30	20.14	27.20	12.80	16.09	21.90	19.40	20.58
	Coagulant Aid (mg/L)					0.22	0.10	0.15	0.21	0.09	0.15	0.15	0.15	0.15
	Metal Res. Al (mg/L)	R												
		T				0.08	0.08	0.08	0.08	0.05	0.07	0.14	0.07	0.10
	pH	R												
		T												
	Temperature (Deg.C.)	R				25.00	19.50	22.30	24.50	18.50	21.00	24.50	17.00	21.90

* INDICATES POLYALUMINUM CHLORIDE

TABLE 2.0: PARTICULATE REMOVAL SUMMARY

			1986			1985			1984			1983		
			MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
OCT	Turbidity (FTU)	R				78.60	3.50	15.80	20.60	2.20	4.87	26.90	2.10	11.26
		T				0.22	0.09	0.12	0.13	0.08	0.10	0.14	0.08	0.09
	Prime Coagulant (mg/L)					44.10	14.40	21.53	21.90	14.20	15.65	25.50	19.00	20.83
	Coagulant Aid (mg/L)					0.27	0.09	0.16	0.19	0.08	0.15	0.15	0.15	0.15
	Metal Res. Al (mg/L)	R												
		T				0.08	0.07	0.07	0.08	0.04	0.06	0.05	0.02	0.04
	pH	R												
		T												
	Temperature (Deg.C.)	R				19.50	13.00	15.30	17.00	15.00	16.30	19.00	10.50	15.10
NOV	Turbidity (FTU)	R				43.90	3.10	12.36	28.50	5.90	15.62	68.00	4.40	14.20
		T				0.23	0.09	0.16	0.30	0.09	0.11	0.16	0.09	0.11
	Prime Coagulant (mg/L)					27.00	15.20	19.75	25.10	15.00	19.86	33.30	19.30	21.64
	Coagulant Aid (mg/L)					0.26	0.09	0.16	0.26	0.09	0.17	0.20	0.15	0.15
	Metal Res. Al (mg/L)	R												
		T				0.09	0.09	0.09	0.07	0.03	0.04	0.05	0.04	0.04
	pH	R												
		T												
	Temperature (Deg.C.)	R				13.00	6.00	9.40	14.50	4.00	8.50	10.50	3.50	7.20
DEC	Turbidity (FTU)	R				99.30	6.90	38.98	62.00	12.30	21.20	107.30	9.60	46.95
		T				0.39	0.14	0.21	0.33	0.11	0.17	0.90	0.12	0.22
	Prime Coagulant (mg/L)					49.80	15.30	27.85	34.80	17.00	22.14	51.40	17.00	31.88
	Coagulant Aid (mg/L)					0.38	0.10	0.21	0.28	0.11	0.18	0.50	0.15	0.23
	Metal Res. Al (mg/L)	R												
		T							0.03	0.02	0.03	0.03	0.01	0.02
	pH	R												
		T												
	Temperature (Deg.C.)	R				6.00	0.50	1.70	4.50	1.00	2.00	1.50	-1.00	0.30

* INDICATES POLYALUMINUM CHLORIDE

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 2.1: PARTICULATE REMOVAL PROFILE (AUG 1983)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	2.60	0.33	0.11	0.11	21.70	0.15						24.0
2	4.00	0.56	0.13	0.12	20.70	0.15						24.0
3	3.20	0.56	0.13	0.15	19.80	0.15						24.0
4	3.20	0.80	0.14	0.13	20.50	0.15						24.0
5	5.90	0.34	0.11	0.12	20.80	0.15						24.0
6	4.30	0.49	0.10	0.10	20.60	0.15						25.0
7	2.40	0.35	0.10	0.10	21.00	0.15						25.0
8	4.30	0.52	0.10	0.10	20.30	0.15						25.0
9	3.10	0.54	0.12	0.11	20.10	0.15						25.0
10	3.50	0.61	0.11	0.12	21.20	0.15						25.0
11	38.40	0.90	0.13	0.13	23.20	0.15						25.0
12	12.30	1.00	0.14	0.17	21.90	0.15						25.0
13	5.70	0.87	0.14	0.13	20.10	0.15			0.04			25.0
14	4.30	0.97	0.13	0.13	20.60	0.15						25.0
15	5.20	0.87	0.10	0.10	20.20	0.15						25.0
16	4.70	0.54	0.10	0.10	19.80	0.15						25.0
17	4.70	0.35	0.09	0.09	19.90	0.15			0.13			25.0
18	5.00	0.20	0.10	0.10	19.90	0.15						25.0
19	4.30	0.63	0.10	0.10	19.90	0.15						25.0
20	3.60	0.41	0.11	0.11	20.20	0.15						25.0
21	3.40	0.69	0.10	0.10	20.30	0.15			0.05			25.0
22	5.70	0.77	0.10	0.10	21.00	0.15						25.0
23	6.00	1.00	0.10	0.09	20.40	0.15						24.5
24	4.00	0.56	0.11	0.11	20.60	0.15						24.5
25	3.90	0.59	0.10	0.10	19.70	0.15						24.5
26	4.20	0.68	0.10	0.10	21.00	0.15						24.5
27	5.00	0.57	0.10	0.10	20.80	0.15						24.5
28	3.00	0.34	0.10	0.10	20.50	0.15						24.5
29	4.20	0.34	0.10	0.10	20.40	0.15			0.10			24.5
30	4.30	0.36	0.10	0.11	21.40	0.15						24.5
31	5.10	0.53	0.12	0.11	20.40	0.15						24.5

TABLE 2.1: PARTICULATE REMOVAL PROFILE (SEP 1983)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	4.20	1.10	0.10	0.10	20.90	0.15						24.5
2	3.10	0.86	0.14	0.10	20.00	0.15						24.5
3	2.80	0.51	0.12	0.13	20.90	0.15						24.5
4	2.50	0.71	0.12	0.10	20.60	0.15						24.5
5	5.00	0.68	0.11	0.11	21.30	0.15						24.5
6	17.90	0.96	0.13	0.12	21.10	0.15						24.5
7	7.30	0.91	0.13	0.13	20.20	0.15						24.5
8	5.40	0.88	0.11	0.11	20.80	0.15						24.5
9	5.60	0.74	0.11	0.11	19.60	0.15						24.5
10	5.80	0.40	0.11	0.10	20.10	0.15						24.5
11	6.00	0.52	0.11	0.11	19.60	0.15						24.5
12	5.60	1.00	0.12	0.13	20.10	0.15			0.14			24.5
13	6.10	1.60	0.12	0.11	20.10	0.15						23.5
14	5.70	0.81	0.12	0.12	20.00	0.15						23.0
15	6.20	0.66	0.11	0.12	19.40	0.15						23.0
16	27.50	0.72	0.12	0.12	21.70	0.15						23.0
17	14.00	0.84	0.11	0.11	20.50	0.15						22.0
18	12.00	0.74	0.11	0.11	21.90	0.15			0.08			21.0
19	12.30	0.69	0.11	0.11	20.80	0.15						21.0
20	12.70	0.84	0.11	0.10	20.70	0.15						21.0
21	12.00	1.10	0.10	0.10	21.10	0.15						21.0
22	12.80	1.40	0.10	0.10	21.20	0.15						20.0
23	14.30	1.30	0.13	0.12	19.60	0.15						20.0
24	8.80	1.30	0.11	0.11	21.00	0.15						18.5
25	6.70	1.20	0.14	0.12	20.90	0.15			0.07			17.5
26	10.80	1.10	0.12	0.12	20.20	0.15						17.0
27	5.90	1.20	0.10	0.10	20.40	0.15						17.0
28	4.10	1.30	0.10	0.09	21.70	0.15						17.0
29	3.30	1.40	0.10	0.09	20.40	0.15						18.0
30	3.10	0.71	0.10	0.10	20.50	0.15						18.0
31												

TABLE 2.1: PARTICULATE REMOVAL PROFILE (OCT 1983)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	3.30	0.57	0.10	0.10	21.20	0.15						19.0
2	2.10	0.70	0.11	0.10	20.90	0.15						19.0
3	7.20	0.72	0.10	0.10	19.80	0.15						19.0
4	6.50	0.62	0.12	0.12	20.10	0.15						19.0
5	5.00	0.41	0.13	0.13	20.00	0.15						19.0
6	5.80	0.74	0.10	0.10	20.60	0.15						19.0
7	6.10	0.70	0.09	0.09	22.20	0.15						18.0
8	8.60	0.56	0.10	0.10	20.40	0.15						18.0
9	5.70	0.79	0.07	0.08	20.40	0.15						18.0
10	4.30	0.71	0.09	0.08	19.90	0.15						17.0
11	18.00	0.62	0.09	0.08	21.10	0.15						16.0
12	16.70	0.47	0.09	0.09	20.80	0.15						16.0
13	9.50	0.84	0.09	0.09	20.10	0.15			0.04			16.0
14	26.90	1.03	0.09	0.09	23.20	0.15						16.0
15	20.80	0.73	0.09	0.09	25.50	0.15						15.0
16	13.30	0.76	0.18	0.08	21.00	0.15			0.05			14.0
17	12.00	1.70	0.12	0.08	20.70	0.15						14.0
18	9.30	1.45	0.11	0.09	21.10	0.15						14.0
19	8.30	1.55	0.11	0.10	19.60	0.15						14.0
20	8.60	1.35	0.09	0.08	20.60	0.15						13.5
21	12.70	1.40	0.09	0.08	20.90	0.15						13.5
22	13.30	1.60	0.11	0.10	21.20	0.15						13.0
23	12.00	0.93	0.08	0.10	21.00	0.15						13.0
24	13.30	1.30	0.10	0.10	19.40	0.15						13.0
25	11.70	1.20	0.10	0.09	20.00	0.15			0.02			13.0
26	9.70	1.00	0.11	0.09	19.00	0.15						12.5
27	9.30	0.94	0.10	0.09	21.20	0.15						12.0
28	24.50	0.75	0.10	0.09	21.20	0.15						11.0
29	19.00	1.10	0.11	0.10	21.60	0.15						11.0
30	14.00	1.20	0.11	0.11	20.40	0.15						11.0
31	11.50	0.84	0.11	0.10	20.50	0.15						10.5

TABLE 2.1: PARTICULATE REMOVAL PROFILE (NOV 1983)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	9.70	0.72	0.12	0.12	20.10	0.15						10.5
2	8.80	0.60	0.12	0.12	21.20	0.15						10.0
3	9.50	1.00	0.13	0.12	21.10	0.15						10.0
4	8.20	1.20	0.12	0.11	21.10	0.15						10.0
5	6.40	0.92	0.11	0.12	20.80	0.15						10.0
6	6.40	0.87	0.12	0.13	20.90	0.15						10.0
7	5.70	0.73	0.11	0.10	20.70	0.15						10.0
8	7.50	0.65	0.09	0.10	20.10	0.15						9.5
9	7.20	0.75	0.10	0.09	25.40	0.15						9.5
10	5.50	1.80	0.09	0.09	24.70	0.15			0.04			9.5
11	4.50	2.20	0.08	0.09	20.30	0.15						9.0
12	5.10	2.10	0.09	0.09	20.80	0.15						8.0
13	4.40	2.20	0.08	0.09	23.00	0.15			0.05			7.0
14	6.50	1.90	0.10	0.10	20.40	0.15						6.5
15	8.70	1.90	0.08	0.10	21.00	0.15						6.5
16	7.10	2.20	0.10	0.09	20.30	0.15						6.5
17	5.90	1.70	0.11	0.11	19.40	0.15						6.0
18	5.50	0.84	0.09	0.11	20.20	0.15						6.0
19	4.60	0.67	0.10	0.10	20.00	0.15						5.5
20	6.10	0.64	0.09	0.09	20.30	0.15						6.0
21	28.80	1.11	0.11	0.10	24.50	0.15						6.0
22	18.50	0.85	0.10	0.10	19.30	0.15			0.04			6.0
23	23.30	0.94	0.12	0.12	19.70	0.15						6.0
24	26.70	1.33	0.13	0.11	21.80	0.15						6.0
25	21.00	1.30	0.14	0.13	19.70	0.15						5.5
26	16.80	0.46	0.11	0.12	20.30	0.15						4.5
27	13.00	0.51	0.11	0.11	20.30	0.15						4.5
28	15.70	1.70	0.12	0.11	19.90	0.15						4.5
29	61.00	2.80	0.18	0.13	28.50	0.20						4.0
30	68.00	2.30	0.16	0.15	33.30	0.20						3.5
31												

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 2.1: PARTICULATE REMOVAL PROFILE (DEC 1983)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	72.30	1.40	0.14	0.13	35.50	0.20			0.03			1.5
2	69.20	1.40	0.13	0.14	34.30	0.20						1.5
3	60.00	1.20	0.12	0.12	30.60	0.20						0.5
4	45.00	1.20	0.15	0.15	34.80	0.20						0.5
5	52.50	1.80	0.20	0.17	27.50	0.20						1.0
6	41.50	3.30	0.30	0.21	27.60	0.15			0.02			1.0
7	79.00	2.30	0.27	0.36	36.90	0.25						0.5
8	107.30	2.00	0.13	0.22	50.80	0.50						0.5
9	93.00	1.40	0.14	0.18	51.40	0.30						0.5
10	74.00	1.80	0.13	0.14	48.90	0.30						0.5
11	66.00	1.70	0.12	0.18	50.50	0.30						0.5
12	59.80	1.70	0.12	0.12	41.40	0.30						0.5
13	44.40	1.30	0.13	0.13	31.70	0.30			0.02			0.5
14	36.80	1.30	0.13	0.13	31.30	0.20						0.5
15	57.60	1.80	0.14	0.14	37.60	0.30						0.5
16	44.00	2.10	0.13	0.15	33.00	0.25						0.0
17	63.70	1.30	0.21	0.15	36.20	0.25						0.0
18	71.30	1.40	0.22	0.19	41.90	0.30						0.0
19	55.00	2.50	0.24	0.22	34.50	0.25			0.03			0.0
20	40.30	4.20	0.31	0.21	34.90	0.25						0.0
21	39.00	3.90	0.17	0.27	29.80	0.25						0.0
22	32.00	4.90	0.37	0.23	25.50	0.20						0.0
23	24.00	3.60	0.24	0.34	23.40	0.15						0.0
24	21.00	2.70	0.20	0.30	21.10	0.15						0.0
25	21.00	2.40	0.20	0.24	21.10	0.15						0.0
26	24.00	2.00	0.14	0.24	19.90	0.15						0.0
27	15.00	1.90	0.02	0.25	20.90	0.15						0.5
28	14.00	1.70	0.90	0.30	17.00	0.15						0.5
29	13.00	1.60	0.12	0.89	20.70	0.15						-1.0
30	10.00	1.50	0.13	0.26	20.00	0.15			0.01			-1.0
31	9.60	1.50	0.63	0.17	17.70	0.15						-1.0

TABLE 2.1: PARTICULATE REMOVAL PROFILE (JAN 1984)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	8.60	1.30	0.15	0.57	20.90	0.15						0.5
2	8.10	1.40	0.14	0.36	19.60	0.15			0.03			0.5
3	8.20	1.50	1.10	0.35	16.10	0.15						0.5
4	6.70	1.60	1.50	1.40	15.20	0.15						0.5
5	6.20	1.50	0.37	1.20	17.90	0.15						0.5
6	5.60	1.40	0.82	0.95	16.30	0.15						0.5
7	5.30	1.30	0.12	0.83	20.10	0.15						0.5
8	5.30	1.70	0.13	0.23	20.30	0.15			0.03			0.5
9	5.10	1.80	0.56	0.25	17.50	0.15						0.5
10	5.20	2.00	0.31	0.61	16.30	0.15						0.5
11	5.20	2.00	0.52	0.50	15.10	0.15						0.5
12	5.00	2.20	0.43	0.56	13.50	0.15						0.5
13	5.00	1.80	0.42	0.49	12.70	0.15						0.5
14	4.70	1.00	0.34	0.54	12.30	0.15						0.5
15	4.60	1.10	0.12	0.53	15.80	0.15			0.02			0.5
16	5.00	1.20	0.22	0.30	13.00	0.15						0.5
17	4.70	1.40	0.25	0.34	12.50	0.15						0.5
18	4.50	1.40	0.43	0.42	11.90	0.15						0.5
19	4.60	1.50	0.22	0.49	13.10	0.15						0.5
20	4.20	1.40	0.16	0.37	14.60	0.15						0.5
21	4.00	1.60	0.15	0.26	14.80	0.15						0.5
22	3.90	1.60	0.09	0.21	15.80	0.15			0.02			0.5
23	3.90	1.60	0.18	0.18	12.00	0.15						0.5
24	4.00	1.60	0.25	0.28	12.20	0.15						0.5
25	4.00	1.70	0.31	0.51	11.70	0.15						0.5
26	3.90	1.70	0.28	0.49	12.20	0.15						0.5
27	3.80	1.60	0.37	0.59	12.60	0.15						0.5
28	3.70	1.70	0.13	0.50	15.60	0.15						0.5
29	3.50	1.60	0.19	0.32	15.50	0.15						0.5
30	3.60	1.70	0.33	0.43	13.80	0.15						0.5
31	3.60	1.80	0.20	0.42	12.30	0.15						0.5

TABLE 2.1: PARTICULATE REMOVAL PROFILE (FEB 1984)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	3.50	1.70	0.23	0.44	13.70	0.15						0.5
2	3.40	1.80	0.28	0.44	11.80	0.15			0.05			0.5
3	3.40	1.90	0.22	0.42	13.90	0.15						0.5
4	3.30	2.20	0.33	0.28	14.20	0.15						0.5
5	3.20	1.90	0.45	0.32	15.20	0.15			0.04			0.5
6	3.50	1.60	0.31	0.43	13.00	0.15						0.5
7	3.40	1.70	0.19	0.30	11.90	0.15						0.5
8	3.40	1.80	0.48	0.33	14.90	0.15						0.5
9	3.30	1.70	0.28	0.43	13.60	0.15						0.5
10	3.30	1.60	0.18	0.26	14.40	0.15						0.5
11	3.10	1.70	0.24	0.20	14.90	0.15						0.5
12	3.10	1.80	0.24	0.28	15.00	0.15			0.03			0.5
13	3.50	1.40	0.16	0.29	13.60	0.15						0.5
14	4.30	1.30	0.14	0.27	14.30	0.15						0.5
15	4.40	1.10	0.22	0.23	13.40	0.15						0.5
16	4.30	1.20	0.27	0.22	12.40	0.15						1.0
17	5.10	1.20	0.20	0.32	13.80	0.15						1.0
18	5.30	1.10	0.08	0.38	15.00	0.15						1.0
19	3.90	0.75	0.09	0.27	15.70	0.15			0.03			1.0
20	3.70	0.93	0.10	0.21	13.10	0.15						1.0
21	3.50	0.94	0.08	0.28	15.00	0.15						1.0
22	3.50	0.98	0.26	0.22	11.80	0.15						1.0
23	3.40	0.91	0.21	0.43	14.00	0.15						1.0
24	3.30	0.97	0.11	0.45	14.40	0.15						1.0
25	3.30	1.00	0.09	0.37	15.10	0.15						1.0
26	3.50	0.95	0.08	0.20	16.80	0.15						1.0
27	4.60	1.10	0.27	0.20	12.90	0.15						1.0
28	58.90	1.40	0.10	0.35	31.30	0.25						0.5
29	34.50	1.40	0.10	0.20	34.80	0.20						0.5
30												
31												

TABLE 2.1: PARTICULATE REMOVAL PROFILE (MAR 1984)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	19.00	2.40	0.14	0.15	19.90	0.15			0.03			0.5
2	15.80	1.20	0.10	0.18	19.70	0.15						0.5
3	9.70	0.95	0.08	0.54	20.30	0.15						1.0
4	8.80	0.91	0.08	0.18	19.90	0.15			0.02			1.0
5	9.20	1.10	0.10	0.20	20.20	0.15						1.0
6	8.50	1.10	0.08	0.13	19.00	0.15						1.0
7	8.10	1.40	0.09	0.13	20.70	0.15						1.0
8	6.30	1.30	0.09	0.15	21.10	0.15						1.0
9	7.70	1.80	0.12	0.14	22.30	0.15						1.0
10	6.20	2.40	0.44	0.28	20.40	0.15						1.0
11	5.30	1.30	0.11	0.43	19.40	0.15			0.06			1.0
12	5.10	1.60	0.21	0.24	22.70	0.15						1.0
13	5.00	1.30	0.43	0.36	16.20	0.15						0.5
14	4.70	1.20	0.39	0.47	12.10	0.15						0.5
15	5.60	1.20	0.15	0.47	13.40	0.15						0.5
16	7.10	1.40	0.24	0.43	16.30	0.15						0.5
17	5.80	1.30	0.14	0.28	14.40	0.15						0.5
18	6.80	1.10	0.17	0.23	16.60	0.15			0.03			0.5
19	8.30	1.20	0.46	0.23	13.20	0.15						0.5
20	6.60	1.20	0.35	0.40	13.20	0.15						0.5
21	14.00	1.00	0.54	0.54	16.70	0.15						0.5
22	83.60	1.90	0.14	0.55	38.40	0.15						0.5
23	11.30	1.70	0.13	0.25	20.40	0.15						0.5
24	22.30	1.30	0.15	0.22	20.00	0.15						0.5
25	14.30	1.60	0.16	0.24	19.90	0.15						1.0
26	9.40	1.40	0.46	0.17	17.80	0.15						1.0
27	7.10	1.20	0.11	0.41	19.10	0.15						1.0
28	5.90	1.20	0.39	0.20	16.70	0.15			0.02			1.0
29	7.20	1.30	0.59	0.61	15.80	0.15						1.0
30	6.60	1.20	0.12	0.49	20.40	0.15						1.0
31	8.20	1.30	0.08	0.23	19.30	0.15						1.0

TABLE 2.1: PARTICULATE REMOVAL PROFILE (APR 1984)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	7.00	1.20	0.09	0.13	22.00	0.15			0.02			2.5
2	7.30	1.20	0.10	0.12	21.10	0.15						3.0
3	5.90	1.40	0.08	0.13	19.30	0.15						3.5
4	5.00	1.20	0.20	0.16	18.60	0.15						3.5
5	3.80	0.94	0.08	0.19	20.80	0.15						3.5
6	5.50	1.00	0.07	0.12	29.00	0.15						3.5
7	4.60	0.97	0.08	0.11	19.10	0.15						3.5
8	4.10	0.81	0.07	0.13	20.60	0.15			0.02			3.5
9	4.90	1.70	0.08	0.16	23.10	0.15						4.0
10	3.90	1.40	0.09	0.11	20.70	0.15						4.0
11	4.40	1.40	0.09	0.15	20.30	0.15						4.0
12	4.10	1.40	0.09	0.12	21.10	0.15						4.5
13	5.90	1.40	0.13	0.18	18.50	0.15						5.0
14	3.10	0.90	0.07	0.13	19.20	0.15						5.5
15	2.40	0.58	0.14	0.14	23.70	0.15			0.02			5.5
16	2.70	0.70	0.06	0.11	20.90	0.15						6.0
17	2.10	0.65	0.09	0.09	22.20	0.15						6.0
18	2.30	0.57	0.09	0.10	22.80	0.15						6.0
19	2.30	0.59	0.11	0.09	20.30	0.15						6.0
20	2.20	0.45	0.08	0.13	20.00	0.15						6.5
21	2.00	0.43	0.09	0.12	22.70	0.15						6.5
22	3.20	0.71	0.10	0.12	22.60	0.15						7.0
23	3.00	0.29	0.11	0.12	22.00	0.15			0.02			6.0
24	2.30	0.30	0.13	0.10	21.30	0.15						6.0
25	5.40	0.35	0.10	0.10	18.20	0.15						6.0
26	3.90	0.40	0.10	0.11	16.20	0.15						6.5
27	3.50	0.31	0.11	0.14	16.20	0.15						7.0
28	4.70	0.32	0.10	0.11	16.10	0.15						8.5
29	4.50	0.47	0.11	0.13	15.60	0.15			0.05			9.0
30	25.70	1.09	0.19	0.20	22.10	0.15						10.5
31												

TABLE 2.1: PARTICULATE REMOVAL PROFILE (MAY 1984)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	59.40	1.20	0.11	0.10	30.70	0.20						10.0
2	42.40	0.77	0.08	0.10	33.20	0.20						10.5
3	31.40	1.00	0.08	0.08	26.50	0.20						10.5
4	24.70	0.85	0.09	0.09	21.30	0.15						10.5
5	19.00	0.92	0.07	0.08	20.90	0.15						10.5
6	17.00	1.30	0.09	0.08	19.60	0.15			0.03			11.0
7	15.70	0.74	0.09	0.10	21.50	0.15						11.5
8	25.80	0.77	0.08	0.09	19.70	0.20						11.0
9	34.50	1.24	0.08	0.09	25.70	0.25						11.5
10	24.50	0.93	0.09	0.08	23.90	0.25						11.0
11	18.30	0.95	0.14	0.13	20.20	0.15						12.0
12	15.70	0.82	0.11	0.11	20.40	0.15						12.0
13	10.10	1.20	0.12	0.11	20.30	0.15			0.06			12.5
14	11.30	0.97	0.11	0.12	20.90	0.15						12.0
15	9.70	1.40	0.12	0.12	19.80	0.15						12.0
16	6.80	0.82	0.09	0.10	20.20	0.15						12.0
17	5.10	0.73	0.07	0.09	17.60	0.15						12.0
18	11.00	0.77	0.10	0.11	16.20	0.15						12.5
19	6.30	0.40	0.08	0.11	18.50	0.15						13.0
20	3.70	0.41	0.09	0.09	21.90	0.15						13.0
21	3.10	0.59	0.09	0.08	18.70	0.15			0.03			13.0
22	3.30	0.63	0.10	0.11	18.10	0.15						14.0
23	3.70	0.64	0.09	0.10	15.80	0.15						14.0
24	2.70	0.59	0.10	0.10	16.20	0.15						14.0
25	7.90	0.98	0.10	0.11	15.40	0.15						14.5
26	5.60	0.49	0.11	0.11	15.20	0.15						15.5
27	3.90	0.78	0.12	0.12	14.50	0.15						15.5
28	4.10	0.86	0.01	0.11	14.90	0.15						15.5
29	13.40	0.73	0.11	0.11	17.20	0.15						15.0
30	11.30	0.61	0.09	0.10	21.60	0.15						15.0
31	5.00	0.56	0.06	0.07	20.80	0.15						14.5

TABLE 2.1: PARTICULATE REMOVAL PROFILE (JUN 1984)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	3.10	0.37	0.05	0.06	20.60	0.15						15.0
2	3.30	0.91	0.06	0.06	20.30	0.15						15.5
3	3.00	0.56	0.07	0.08	20.10	0.15			0.05			16.5
4	3.30	0.57	0.07	0.08	20.20	0.15						16.5
5	2.40	1.20	0.08	0.09	20.40	0.15						18.0
6	3.00	0.72	0.09	0.10	21.00	0.15						19.5
7	4.80	0.57	0.10	0.10	19.80	0.15						21.0
8	23.00	0.60	0.11	0.14	19.80	0.15						20.5
9	6.90	0.33	0.10	0.10	19.90	0.15						20.5
10	6.70	0.39	0.09	0.10	21.00	0.15			0.07			20.5
11	7.50	0.68	0.10	0.09	19.50	0.15						20.5
12	5.10	0.76	0.10	0.10	19.70	0.15						21.0
13	4.20	0.32	0.10	0.11	19.20	0.15						21.0
14	6.70	0.54	0.12	0.12	19.80	0.15						21.0
15	6.60	0.84	0.12	0.13	20.30	0.15						20.5
16	6.10	0.49	0.12	0.12	20.10	0.15						20.5
17	3.30	0.28	0.12	0.12	19.30	0.15						20.5
18	4.50	0.45	0.14	0.14	19.40	0.15						20.5
19	4.10	0.35	0.13	0.13	19.70	0.15						21.0
20	3.00	0.96	0.13	0.11	20.60	0.15						22.0
21	2.90	0.63	0.13	0.12	19.50	0.15						22.5
22	3.60	0.58	0.14	0.14	20.30	0.15						22.5
23	3.80	0.59	0.15	0.14	18.90	0.15						22.5
24	3.50	0.56	0.12	0.13	19.70	0.15			0.09			22.5
25	4.80	0.50	0.10	0.10	20.40	0.15						22.5
26	4.20	1.10	0.10	0.10	19.50	0.15						22.0
27	29.00	1.00	0.10	0.10	24.10	0.15						22.5
28	18.00	0.56	0.07	0.07	22.10	0.15						22.5
29	8.60	0.38	0.07	0.08	20.10	0.15						23.0
30	7.60	0.74	0.10	0.09	20.60	0.15						22.5
31												

TABLE 2.1: PARTICULATE REMOVAL PROFILE (JUL 1984)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	6.60	0.60	0.10	0.09	20.30	0.15						22.0
2	4.70	0.77	0.09	0.09	20.20	0.15			0.07			22.5
3	5.60	0.40	0.11	0.11	20.80	0.15						22.0
4	4.80	0.80	0.12	0.11	19.00	0.15						23.0
5	3.70	0.87	0.11	0.11	19.80	0.15						22.5
6	12.80	0.53	0.11	0.11	19.90	0.15						22.5
7	6.60	0.90	0.11	0.11	20.90	0.15						22.5
8	4.20	1.00	0.11	0.10	19.70	0.15			0.10			22.5
9	19.60	0.92	0.11	0.11	19.40	0.15						22.5
10	15.30	0.46	0.13	0.14	20.30	0.15						22.5
11	9.70	0.55	0.12	0.12	20.00	0.15						22.5
12	6.20	0.62	0.07	0.08	18.40	0.15						22.5
13	5.30	0.45	0.08	0.09	20.30	0.15						22.5
14	3.50	0.41	0.07	0.06	19.80	0.15						22.5
15	4.50	0.32	0.06	0.07	20.40	0.15						22.5
16	5.60	0.78	0.08	0.07	19.00	0.15						23.5
17	7.90	0.82	0.06	0.06	19.70	0.15						23.0
18	7.10	0.72	0.06	0.06	19.60	0.15			0.07			21.5
19	5.10	0.94	0.07	0.08	20.00	0.15						21.0
20	4.80	0.80	0.07	0.07	19.90	0.15						21.5
21	4.10	0.44	0.06	0.07	20.00	0.15						22.0
22	2.40	0.41	0.07	0.07	19.60	0.15			0.07			22.5
23	1.90	1.75	0.08	0.07	13.90	0.15						24.0
24	2.50	0.52	0.08	0.09	16.00	0.15						22.5
25	2.70	0.61	0.06	0.07	16.20	0.15						23.0
26	2.10	0.55	0.06	0.07	15.20	0.15						23.5
27	3.60	0.45	0.07	0.07	15.80	0.15						23.0
28	1.90	0.68	0.08	0.07	15.50	0.15						23.0
29	1.90	0.70	0.09	0.07	13.50	0.15						23.0
30	2.90	0.70	0.11	0.08	16.30	0.15						23.0
31	2.50	0.37	0.07	0.10	15.30	0.15			0.10			24.0

TABLE 2.1: PARTICULATE REMOVAL PROFILE (AUG 1984)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	1.90	0.42	0.08	0.09	15.40	0.15						24.5
2	1.90	0.51	0.08	0.09	14.80	0.15						24.5
3	1.40	0.21	0.08	0.10	15.00	0.15						24.5
4	1.40	0.49	0.07	0.07	15.70	0.15						24.5
5	1.50	0.15	0.06	0.06	13.40	0.15						25.0
6	1.50	0.37	0.07	0.07	15.40	0.15			0.08			24.0
7	3.40	0.19	0.07	0.08	14.80	0.15						24.0
8	2.40	1.70	0.08	0.07	14.80	0.15						25.0
9	4.90	0.20	0.07	0.09	15.40	0.15						25.0
10	2.90	0.50	0.08	0.09	15.30	0.15						25.5
11	3.20	0.20	0.08	0.08	15.00	0.15						25.5
12	3.70	0.62	0.08	0.08	14.80	0.15						24.5
13	3.90	1.10	0.09	0.09	14.60	0.15						23.0
14	3.90	0.30	0.09	0.08	15.20	0.15						23.5
15	2.50	0.36	0.09	0.09	15.00	0.15			0.07			23.0
16	2.40	0.30	0.10	0.10	14.90	0.15						24.0
17	1.80	0.80	0.09	0.08	14.90	0.15						24.0
18	1.40	0.40	0.08	0.08	14.50	0.15						25.0
19	1.60	0.57	0.08	0.07	14.70	0.15			0.09			25.0
20	2.00	0.63	0.07	0.07	14.60	0.15						24.0
21	2.70	0.70	0.08	0.08	14.50	0.15						24.0
22	5.90	0.48	0.08	0.10	15.30	0.15						24.5
23	5.00	0.56	0.09	0.08	15.60	0.15						24.5
24	3.70	0.63	0.08	0.07	14.70	0.15						24.5
25	3.50	0.89	0.07	0.07	16.10	0.15						24.0
26	2.90	0.25	0.09	0.08	15.30	0.15						23.0
27	10.00	0.54	0.09	0.09	16.10	0.15						24.5
28	4.50	0.50	0.11	0.11	16.20	0.15						24.5
29	7.60	0.43	0.12	0.12	14.30	0.15			0.13			24.5
30	12.00	0.46	0.12	0.12	15.20	0.15						24.5
31	8.80	0.89	0.09	0.10	15.40	0.15						24.5

TABLE 2.1: PARTICULATE REMOVAL PROFILE (SEP 1984)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	5.40	0.81	0.10	0.09	15.50	0.13						24.5
2	10.20	0.73	0.10	0.10	14.10	0.09			0.08			24.0
3	8.80	0.70	0.11	0.11	16.00	0.18						23.5
4	6.50	1.07	0.10	0.10	15.20	0.14						23.0
5	5.10	1.20	0.10	0.11	15.10	0.15						22.0
6	5.00	1.11	0.09	0.10	14.80	0.14						22.0
7	31.80	0.80	0.12	0.11	18.00	0.16						22.0
8	40.40	0.75	0.10	0.10	27.20	0.18						21.5
9	23.00	1.60	0.10	0.11	22.80	0.12						21.0
10	13.10	0.97	0.11	0.12	19.60	0.17						21.0
11	8.20	0.84	0.09	0.09	15.30	0.16						21.0
12	6.10	0.98	0.09	0.09	14.50	0.11						21.0
13	12.00	0.69	0.10	0.10	15.10	0.17						21.5
14	6.70	0.88	0.10	0.11	15.90	0.11						21.5
15	5.20	0.88	0.08	0.09	14.90	0.21						21.0
16	4.50	0.84	0.09	0.09	18.80	0.14			0.08			20.5
17	5.10	0.81	0.10	0.10	15.00	0.12						20.0
18	5.20	0.64	0.10	0.11	14.90	0.15						20.0
19	6.50	0.53	0.10	0.10	14.70	0.16						20.0
20	13.00	0.63	0.10	0.10	15.10	0.15						19.5
21	7.10	1.10	0.11	0.10	14.80	0.16						21.0
22	5.90	0.57	0.09	0.09	14.80	0.13						19.5
23	4.50	0.86	0.11	0.12	12.80	0.11			0.05			20.5
24	6.10	0.45	0.11	0.11	15.30	0.19						20.5
25	9.00	0.64	0.10	0.12	15.40	0.12						21.0
26	8.10	1.21	0.11	0.12	15.30	0.17						21.0
27	5.80	1.08	0.10	0.09	15.00	0.12						19.5
28	5.60	1.03	0.11	0.09	15.30	0.19						19.0
29	5.20	1.08	0.10	0.10	15.30	0.09						18.5
30	4.10	1.12	0.10	0.09	16.10	0.21			0.07			18.5
31												

TABLE 2.1: PARTICULATE REMOVAL PROFILE (OCT 1984)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	4.30	1.20	0.10	0.10	15.30	0.13						17.0
2	4.70	1.05	0.10	0.10	15.20	0.19						16.5
3	20.60	1.03	0.10	0.10	21.90	0.18						16.5
4	9.70	1.35	0.10	0.10	16.70	0.12						16.0
5	7.00	1.10	0.08	0.09	14.70	0.19						16.0
6	5.40	0.59	0.09	0.10	15.60	0.10						16.0
7	4.80	0.44	0.10	0.10	14.40	0.12						16.0
8	4.80	0.76	0.10	0.10	15.40	0.18						16.5
9	6.00	0.52	0.10	0.11	15.30	0.15						16.5
10	4.70	0.63	0.10	0.10	15.70	0.16						16.5
11	4.20	0.76	0.10	0.10	16.00	0.14			0.07			17.0
12	2.80	0.61	0.10	0.10	16.30	0.17						17.0
13	2.20	0.60	0.10	0.10	15.50	0.15						17.0
14	2.40	0.56	0.09	0.09	15.20	0.13			0.08			17.0
15	2.70	0.42	0.10	0.10	16.70	0.18						17.0
16	2.60	0.55	0.11	0.11	14.80	0.19						17.0
17	2.30	0.26	0.08	0.08	14.70	0.08						17.0
18	2.40	0.38	0.08	0.09	15.80	0.18						17.0
19	4.90	0.41	0.08	0.09	15.00	0.18						17.0
20	5.80	0.39	0.08	0.08	15.60	0.12						17.0
21	3.90	0.41	0.10	0.08	15.30	0.17						17.0
22	4.50	0.35	0.09	0.10	14.40	0.10						17.0
23	5.70	0.60	0.10	0.10	15.60	0.19			0.04			16.0
24	3.60	0.47	0.09	0.10	15.00	0.18						16.0
25	2.90	0.42	0.10	0.11	15.10	0.18						15.0
26	4.30	0.43	0.11	0.10	15.30	0.17						15.0
27	3.50	0.38	0.10	0.10	14.20	0.12						15.0
28	3.90	0.31	0.10	0.10	14.30	0.16						15.0
29	4.60	0.50	0.09	0.10	15.00	0.10						15.0
30	5.90	0.40	0.09	0.10	21.00	0.15						15.0
31	4.00	0.83	0.08	0.09	14.30	0.17						15.0

TABLE 2.1: PARTICULATE REMOVAL PROFILE (NOV 1984)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	23.10	1.45	0.10	0.09	16.90	0.19						14.5
2	16.00	1.71	0.08	0.09	25.10	0.18						14.0
3	16.20	1.61	0.09	0.09	19.60	0.24						13.0
4	12.80	2.53	0.09	0.09	25.10	0.20						12.5
5	17.70	1.29	0.09	0.09	20.30	0.10						12.5
6	11.70	0.86	0.09	0.09	21.60	0.18						12.0
7	7.20	0.84	0.09	0.09	18.80	0.10						11.5
8	17.00	1.11	0.10	0.10	15.40	0.18			0.04			11.5
9	22.00	0.48	0.09	0.10	18.80	0.19						11.0
10	22.60	0.53	0.09	0.10	21.50	0.13			0.07			10.5
11	14.50	1.80	0.10	0.11	21.70	0.21						10.5
12	9.20	1.39	0.11	0.11	23.70	0.17						10.0
13	7.30	0.95	0.11	0.11	20.30	0.09						9.5
14	5.90	0.68	0.10	0.10	19.40	0.18						9.0
15	17.80	1.32	0.11	0.11	20.70	0.19						8.5
16	25.50	1.21	0.12	0.12	21.90	0.09						8.5
17	16.80	1.01	0.13	0.13	19.40	0.26						8.0
18	12.40	0.55	0.12	0.15	21.50	0.15						7.5
19	10.60	0.73	0.12	0.12	19.60	0.21						7.0
20	7.60	0.71	0.12	0.14	16.80	0.10			0.03			6.5
21	7.50	0.52	0.10	0.13	15.00	0.25						5.5
22	16.10	0.88	0.10	0.12	16.50	0.09						5.5
23	28.50	0.74	0.10	0.11	23.40	0.22						4.5
24	17.00	0.49	0.08	0.10	18.90	0.13						4.0
25	15.00	0.42	0.10	0.10	22.90	0.16			0.03			4.0
26	16.30	0.44	0.10	0.10	17.30	0.23						4.0
27	18.80	0.66	0.12	0.12	15.80	0.12						4.5
28	21.80	1.21	0.12	0.11	16.40	0.22						5.0
29	17.00	0.59	0.10	0.10	21.00	0.11						5.0
30	16.70	0.65	0.17	0.17	20.60	0.11						5.0
31												

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 2.1: PARTICULATE REMOVAL PROFILE (DEC 1984)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	16.70	0.78	0.11	0.11	20.90	0.13						4.5
2	13.10	0.62	0.11	0.11	28.10	0.28						4.5
3	16.80	1.34	0.12	0.12	20.80	0.13						4.0
4	21.50	0.86	0.12	0.13	19.60	0.24						4.0
5	17.30	0.41	0.11	0.13	20.80	0.13						2.5
6	16.70	0.48	0.10	0.12	19.80	0.11						2.5
7	33.80	1.01	0.11	0.12	23.40	0.24						2.0
8	32.90	0.76	0.11	0.12	29.50	0.13			0.03			1.0
9	16.00	0.35	0.11	0.17	29.90	0.23						1.0
10	14.70	0.55	0.10	0.18	19.90	0.27						1.0
11	14.00	0.50	0.10	0.18	17.30	0.27						1.0
12	23.00	0.58	0.10	0.14	17.00	0.13						1.0
13	18.00	0.57	0.12	0.15	19.60	0.13						1.5
14	17.00	0.84	0.14	0.13	18.50	0.27						1.5
15	17.30	0.67	0.12	0.15	24.20	0.15						2.0
16	20.30	1.00	0.17	0.24	19.30	0.19						2.0
17	22.00	0.60	0.14	0.25	20.20	0.16			0.02			2.5
18	15.00	0.57	0.17	0.21	23.30	0.18						2.5
19	15.00	0.68	0.13	0.17	21.80	0.17						2.5
20	16.70	1.37	0.15	0.18	19.40	0.19						2.5
21	13.60	1.09	0.13	0.15	18.60	0.18						2.0
22	24.40	3.32	0.35	0.16	21.60	0.13						2.0
23	62.00	1.50	0.18	0.25	25.30	0.17						2.0
24	55.00	1.20	0.15	0.21	34.80	0.21						1.5
25	37.20	2.10	0.20	0.19	25.50	0.27						1.5
26	15.20	1.02	0.16	0.19	22.00	0.15						1.0
27	14.70	1.40	0.15	0.20	20.40	0.14						1.0
28	12.30	0.78	0.19	0.26	20.00	0.24						1.0
29	18.30	2.00	0.22	0.21	21.60	0.14						1.0
30	12.80	0.77	0.14	0.19	22.80	0.22						1.5
31	14.00	1.00	0.13	0.17	20.30	0.13						2.0

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 2.1: PARTICULATE REMOVAL PROFILE (JAN 1985)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	26.00	2.40	0.17	0.17	22.50	0.20						2.0
2	42.10	2.80	0.14	0.21	25.00	0.13						2.0
3	21.00	3.50	0.15	0.22	20.90	0.20						1.5
4	18.50	2.20	0.12	0.24	21.90	0.12						1.5
5	26.30	1.70	0.13	0.19	21.50	0.13						1.0
6	57.30	1.60	0.18	0.25	31.50	0.32			0.03			1.0
7	31.30	1.25	0.11	0.19	27.90	0.27						1.0
8	25.20	1.34	0.16	0.16	24.60	0.11						0.5
9	15.30	1.15	0.12	0.16	20.80	0.13						0.5
10	19.00	1.27	0.12	0.16	20.10	0.12						0.5
11	12.70	1.57	0.13	0.17	20.00	0.13						0.5
12	14.30	1.73	0.14	0.22	18.80	0.27						0.5
13	16.70	1.53	0.17	0.33	20.50	0.17						0.5
14	13.30	1.65	0.15	0.35	20.70	0.13						0.5
15	8.60	1.70	0.16	0.34	16.00	0.11			0.03			0.5
16	8.30	1.13	0.16	0.25	16.40	0.27						0.5
17	7.90	1.37	0.16	0.31	14.00	0.11						0.5
18	7.20	0.97	0.16	0.23	15.00	0.13						0.5
19	7.20	0.98	0.16	0.25	14.60	0.13						0.5
20	8.60	1.07	0.16	0.21	14.70	0.13			0.04			0.5
21	8.70	1.10	0.19	0.26	15.40	0.12						0.5
22	9.10	1.30	0.22	0.39	14.60	0.23						0.5
23	7.50	1.20	0.24	0.37	14.10	0.12						0.5
24	6.50	1.20	0.22	0.39	15.00	0.12						0.5
25	4.80	0.80	0.17	0.31	15.70	0.26						0.5
26	5.40	0.91	0.13	0.19	14.60	0.13						0.5
27	4.10	0.82	0.14	0.24	14.60	0.13						0.5
28	4.60	1.20	0.16	0.32	15.10	0.11						0.5
29	3.80	1.10	0.16	0.20	15.60	0.23			0.06			0.5
30	4.20	1.00	0.21	0.37	14.90	0.12						0.5
31	3.70	0.93	0.16	0.40	14.00	0.13						0.5

TABLE 2.1: PARTICULATE REMOVAL PROFILE (FEB 1985)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	3.70	1.10	0.18	0.33	14.70	0.12						0.5
2	3.30	1.10	0.12	0.29	13.90	0.13			0.04			0.5
3	3.60	1.20	0.24	0.26	13.40	0.11						0.5
4	3.30	2.10	0.38	0.24	12.90	0.22						0.5
5	3.10	1.45	0.27	0.41	13.20	0.12						0.5
6	2.90	1.20	0.19	0.30	12.50	0.11						0.5
7	3.00	1.50	0.28	0.27	13.70	0.13						0.5
8	2.50	1.20	0.20	0.34	14.60	0.13						0.5
9	2.50	2.15	0.29	0.33	14.60	0.13						0.5
10	2.40	2.52	0.28	0.40	15.70	0.25						0.5
11	2.40	2.20	0.25	0.43	14.40	0.11						0.5
12	2.70	2.33	0.34	0.27	13.00	0.10						0.5
13	2.40	1.73	0.39	0.68	11.80	0.13			0.03			0.5
14	2.10	1.08	0.17	0.36	14.60	0.13						0.5
15	2.00	0.99	0.16	0.19	14.50	0.12						0.5
16	2.00	0.88	0.13	0.30	15.20	0.12						0.5
17	1.90	0.81	0.11	0.14	14.50	0.26						0.5
18	1.70	0.81	0.11	0.17	15.60	0.13						0.5
19	2.70	1.10	0.21	0.14	11.90	0.11						0.5
20	1.60	2.20	0.30	0.27	14.50	0.13						0.5
21	1.90	1.49	0.44	0.30	11.00	0.10						0.5
22	1.70	1.15	0.19	0.33	14.40	0.12						0.5
23	1.70	1.17	0.14	0.24	14.30	0.13						0.5
24	3.80	1.04	0.16	0.19	14.30	0.13						0.5
25	12.80	1.40	0.14	0.17	15.40	0.25						0.5
26	6.10	1.00	0.14	0.19	13.80	0.12						0.5
27	6.60	1.20	0.34	0.39	12.50	0.10						0.5
28	6.30	1.10	0.55	0.53	11.10	0.10			0.05			0.5
29												
30												
31												

TABLE 2.1: PARTICULATE REMOVAL PROFILE (MAR 1985)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	4.70	1.00	0.59	0.61	13.30	0.11						0.5
2	2.10	0.97	0.11	0.46	13.80	0.12			0.02			0.5
3	2.10	0.95	0.11	0.30	15.00	0.12						0.5
4	7.90	1.10	0.10	0.23	14.90	0.24						0.5
5	34.60	1.46	0.12	0.17	24.60	0.12						0.5
6	17.80	1.85	0.12	0.14	21.00	0.12						0.5
7	12.80	1.16	0.49	0.19	18.30	0.11						0.5
8	11.40	1.43	0.14	0.35	18.90	0.25						0.5
9	9.90	1.47	0.14	0.22	19.00	0.13						0.5
10	7.80	1.57	0.18	0.19	19.00	0.13						0.5
11	6.60	1.53	0.13	0.23	18.90	0.13						0.5
12	5.00	4.95	0.44	0.30	19.20	0.13						0.5
13	5.50	1.00	0.15	0.34	18.70	0.25						0.5
14	6.60	1.33	0.15	0.21	18.60	0.12			0.02			0.5
15	6.70	1.55	0.10	0.14	19.90	0.12						0.5
16	6.90	1.22	0.11	0.13	19.20	0.12						0.5
17	7.90	1.33	0.12	0.14	20.30	0.18						0.5
18	10.60	1.17	0.41	0.14	16.90	0.12						0.5
19	30.90	1.06	0.21	0.41	21.10	0.12			0.04			0.5
20	31.40	1.95	0.23	0.37	23.50	0.10						0.5
21	20.40	1.74	0.13	0.17	22.60	0.18						1.5
22	13.50	1.80	0.13	0.15	20.30	0.10						1.0
23	7.00	1.10	0.13	0.15	19.40	0.12						1.5
24	6.90	1.10	0.15	0.17	19.50	0.14						2.0
25	7.50	1.10	0.15	0.15	19.90	0.23						2.0
26	7.60	1.10	0.15	0.18	15.50	0.11						2.5
27	29.50	1.10	0.13	0.24	25.50	0.10						3.0
28	30.00	1.20	0.11	0.20	25.30	0.20						3.0
29	18.80	1.50	0.13	0.20	20.90	0.10						3.5
30	16.50	1.00	0.14	0.15	19.50	0.16						4.8
31	22.50	1.70	0.15	0.15	27.20	0.23			0.01			4.8

TABLE 2.1: PARTICULATE REMOVAL PROFILE (APR 1985)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	105.30	3.46	0.18	0.15	39.30	0.19						4.0
2	98.50	2.67	0.16	0.15	78.00	0.29						3.5
3	82.40	5.68	0.39	0.19	48.20	0.22						3.5
4	61.10	4.01	0.30	0.36	47.30	0.22						4.0
5	70.60	3.23	0.23	0.33	49.90	0.27						4.5
6	104.50	6.76	0.42	0.31	48.30	0.15						5.0
7	121.60	6.40	0.20	0.30	52.20	0.28						5.0
8	75.30	4.53	0.13	0.17	60.30	0.30						5.0
9	71.70	4.24	0.13	0.14	48.90	0.27						5.0
10	98.50	5.50	0.20	0.20	21.60	0.33						5.0
11	58.30	2.94	0.18	0.19	32.70	0.22			0.02			5.5
12	40.30	1.34	0.15	0.17	31.50	0.26						5.5
13	42.80	0.87	0.14	0.16	30.00	0.26						6.0
14	44.00	0.71	0.18	0.18	30.30	0.15						6.5
15	37.80	1.11	0.16	0.20	28.30	0.30						7.0
16	28.50	1.15	0.19	0.18	20.80	0.10						7.5
17	25.20	1.18	0.18	0.19	20.20	0.21						7.5
18	46.00	0.91	0.15	0.20	26.20	0.17						7.0
19	29.80	0.80	0.18	0.22	26.70	0.09						7.5
20	28.00	0.91	0.16	0.16	24.40	0.22						8.0
21	20.30	1.13	0.16	0.17	19.50	0.15						8.5
22	19.00	0.97	0.14	0.16	20.80	0.16						9.0
23	13.20	1.05	0.11	0.13	18.80	0.14						11.5
24	6.20	1.30	0.11	0.14	20.40	0.14						13.5
25	11.80	0.77	0.11	0.17	19.20	0.16			0.03			11.7
26	10.30	0.94	0.10	0.12	19.80	0.15						8.0
27	9.70	1.40	0.10	0.12	20.50	0.19			0.03			8.5
28	9.20	1.35	0.12	0.13	19.30	0.12						9.0
29	10.30	1.49	0.14	0.15	21.10	0.17						9.0
30	10.10	1.07	0.11	0.13	20.60	0.16						9.0
31												

TABLE 2.1: PARTICULATE REMOVAL PROFILE (MAY 1985)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	10.20	1.04	0.10	0.10	20.30	0.17						9.0
2	10.20	1.53	0.12	0.10	21.10	0.09						10.0
3	14.20	2.81	0.24	0.15	21.30	0.21						10.5
4	9.20	0.79	0.11	0.17	20.50	0.09						11.5
5	13.00	1.24	0.12	0.14	21.50	0.18						11.5
6	16.00	0.80	0.13	0.15	20.70	0.18						12.8
7	10.20	1.06	0.13	0.13	21.10	0.15						13.5
8	7.20	0.88	0.13	0.13	20.80	0.15			0.06			13.3
9	12.90	1.08	0.17	0.14	18.20	0.19						14.0
10	10.10	1.05	0.13	0.24	20.60	0.12						14.7
11	7.90	1.00	0.12	0.13	20.30	0.20						14.7
12	5.60	0.81	0.13	0.13	20.30	0.07			0.08			17.0
13	7.30	0.87	0.13	0.12	19.70	0.20						17.5
14	6.40	1.08	0.16	0.15	17.70	0.12						17.0
15	4.70	0.50	0.14	0.15	19.90	0.22			0.09			18.0
16	7.80	0.70	0.15	0.15	19.80	0.07						18.0
17	5.80	1.18	0.16	0.19	21.40	0.09						18.0
18	4.10	0.73	0.15	0.16	19.70	0.13						17.0
19	11.00	0.45	0.16	0.15	20.40	0.22						17.0
20	14.70	0.83	0.15	0.17	20.10	0.10						17.0
21	8.10	0.66	0.15	0.16	21.00	0.16						17.0
22	6.00	1.00	0.15	0.15	20.60	0.15						17.0
23	7.70	1.00	0.16	0.16	19.80	0.14						17.2
24	7.00	0.73	0.16	0.17	19.30	0.18						17.7
25	5.70	0.64	0.13	0.13	20.50	0.07						17.7
26	7.10	0.50	0.10	0.11	21.90	0.15						17.0
27	4.60	1.00	0.11	0.11	20.00	0.16						18.5
28	4.50	0.89	0.11	0.12	19.90	0.16						18.5
29	4.00	0.87	0.11	0.11	19.20	0.15						18.5
30	11.00	0.78	0.13	0.11	20.60	0.17						18.5
31	22.10	0.81	0.13	0.14	19.70	0.09						18.5

TABLE 2.1: PARTICULATE REMOVAL PROFILE (JUN 1985)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	14.20	0.62	0.15	0.15	19.10	0.21						19.0
2	5.40	0.33	0.12	0.15	17.90	0.12						18.5
3	5.30	0.65	0.14	0.16	20.00	0.18						18.7
4	7.70	1.01	0.13	0.15	24.40	0.17						19.0
5	5.90	0.58	0.15	0.16	20.90	0.16						19.0
6	6.20	0.90	0.15	0.17	20.60	0.14						19.0
7	6.50	0.97	0.13	0.14	21.00	0.13						19.2
8	3.10	0.71	0.14	0.15	19.90	0.21						20.0
9	8.50	0.68	0.13	0.13	19.60	0.10			0.09			20.2
10	7.50	0.61	0.10	0.10	20.10	0.18						21.0
11	5.20	1.37	0.11	0.13	19.80	0.16						21.5
12	11.7	0.73	0.14	0.14	20.5	0.09						19.5
13	10.10	0.78	0.13	0.14	20.80	0.19						20.0
14	11.30	0.58	0.13	0.13	19.80	0.18						19.0
15	13.10	0.71	0.20	0.13	20.80	0.11						19.0
16	23.70	0.77	0.14	0.14	20.10	0.16						19.0
17	16.00	0.89	0.16	0.16	18.40	0.19						19.0
18	23.00	0.93	0.13	0.17	19.50	0.17						19.5
19	13.30	0.94	0.14	0.15	22.10	0.09						19.5
20	12.00	0.88	0.14	0.15	19.90	0.16						19.5
21	10.60	0.97	0.14	0.15	20.20	0.14						19.5
22	29.00	0.95	0.14	0.13	23.20	0.22			0.07			20.5
23	15.30	0.57	0.13	0.14	19.00	0.12						20.6
24	12.30	1.02	0.13	0.13	20.00	0.15						20.5
25	10.90	0.99	0.14	0.14	21.20	0.14						21.0
26	7.80	1.27	0.15	0.15	19.90	0.18						21.5
27	7.40	0.98	0.15	0.16	19.80	0.18						21.5
28	8.30	0.90	0.14	0.14	20.80	0.11						21.5
29	7.30	0.43	0.12	0.14	19.10	0.21						22.0
30	5.80	0.81	0.13	0.14	20.20	0.14						21.5
31												

TABLE 2.1: PARTICULATE REMOVAL PROFILE (JUL 1985)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	5.40	0.66	0.13	0.13	19.60	0.15						21.8
2	9.80	0.56	0.17	0.17	20.00	0.13			0.06			22.3
3	9.30	0.60	0.14	0.15	20.40	0.15						22.0
4	8.00	0.53	0.16	0.15	17.70	0.17						22.3
5	8.50	0.85	0.15	0.14	20.00	0.14						23.0
6	6.60	0.71	0.15	0.15	18.70	0.12						23.5
7	5.30	0.69	0.15	0.14	19.40	0.22						23.5
8	9.90	0.58	0.13	0.12	19.50	0.17						23.5
9	9.20	0.47	0.12	0.12	19.90	0.19						23.5
10	9.60	0.52	0.11	0.13	21.00	0.13						23.5
11	8.00	0.71	0.11	0.12	20.80	0.13						23.5
12	7.70	0.55	0.12	0.12	21.20	0.15						23.5
13	12.70	0.66	0.13	0.13	19.50	0.16						24.5
14	6.90	0.56	0.16	0.14	20.40	0.10						24.5
15	5.40	0.33	0.14	0.15	19.10	0.18						25.0
16	5.10	0.56	0.12	0.12	20.60	0.15						25.0
17	4.00	1.35	0.12	0.12	21.50	0.14						25.0
18	4.00	0.94	0.13	0.13	17.90	0.13						25.0
19	4.30	0.80	0.16	0.18	14.50	0.12						25.5
20	5.90	0.33	0.13	0.14	14.50	0.15			0.21			24.5
21	4.10	0.46	0.13	0.12	14.50	0.18						25.0
22	7.00	0.93	0.14	0.14	15.20	0.12						25.0
23	4.60	1.13	0.13	0.14	15.00	0.16						24.5
24	5.30	0.73	0.11	0.12	18.80	0.16						24.5
25	10.00	0.68	0.12	0.12	19.70	0.15						25.0
26	4.60	0.51	0.13	0.12	20.80	0.16						25.0
27	3.40	0.98	0.12	0.13	19.30	0.17						25.5
28	3.30	0.63	0.13	0.14	19.70	0.13						25.5
29	4.70	0.89	0.12	0.12	19.40	0.18						25.5
30	4.00	1.10	0.13	0.14	20.00	0.15						25.0
31	3.20	0.88	0.12	0.15	20.40	0.14			0.08			24.5

TABLE 2.1: PARTICULATE REMOVAL PROFILE (AUG 1985)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	3.90	0.89	0.13	0.14	19.80	0.16						24.5
2	3.90	0.95	0.12	0.12	20.80	0.15						23.5
3	3.30	1.00	0.13	0.13	19.20	0.10						23.5
4	1.70	0.89	0.13	0.14	19.20	0.13						24.0
5	6.20	0.70	0.15	0.15	20.00	0.14						24.5
6	16.20	0.67	0.18	0.16	18.80	0.14						24.5
7	6.50	0.87	0.18	0.19	19.60	0.13						24.5
8	4.50	0.66	0.18	0.18	18.90	0.11						24.5
9	4.20	0.80	0.20	0.19	19.90	0.13						24.5
10	2.60	1.01	0.19	0.22	20.80	0.17						24.5
11	3.90	0.98	0.18	0.19	20.70	0.15						24.5
12	3.50	1.18	0.19	0.19	18.90	0.15						25.0
13	2.80	0.66	0.20	0.20	19.10	0.15						25.0
14	3.10	0.62	0.19	0.21	20.00	0.11						25.0
15	2.90	0.86	0.19	0.21	20.70	0.17						25.0
16	5.30	0.99	0.20	0.20	21.30	0.21						25.0
17	3.70	1.00	0.19	0.19	20.90	0.15			0.11			25.6
18	2.60	0.85	0.16	0.17	18.50	0.12						25.0
19	4.80	0.86	0.15	0.14	20.40	0.14						24.5
20	5.10	0.88	0.14	0.14	20.30	0.17						24.0
21	4.40	0.66	0.14	0.14	19.40	0.11						23.5
22	4.60	0.64	0.14	0.14	19.30	0.17						23.5
23	4.50	0.82	0.14	0.15	20.40	0.17						23.5
24	5.10	0.86	0.16	0.16	20.70	0.14						23.5
25	4.60	0.47	0.16	0.15	19.80	0.12						23.5
26	4.60	0.86	0.15	0.16	20.00	0.20						23.0
27	6.20	0.64	0.16	0.16	19.70	0.06						23.0
28	4.50	0.85	0.15	0.14	20.00	0.17						23.5
29	4.00	0.77	0.15	0.02	19.80	0.17			0.10			23.5
30	5.10	0.72	0.14	0.14	19.60	0.16						23.5
31	4.00	0.96	0.12	0.13	19.50	0.13						23.2

TABLE 2.1: PARTICULATE REMOVAL PROFILE (SEP 1985)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	3.00	0.71	0.13	0.13	18.40	0.19						23.3
2	5.90	0.97	0.14	0.14	20.20	0.15						23.5
3	5.40	0.74	0.16	0.17	20.30	0.16						23.5
4	5.20	0.70	0.16	0.15	19.40	0.10						24.0
5	6.20	0.66	0.15	0.16	20.30	0.15						24.5
6	6.20	0.66	0.16	0.16	20.10	0.16						24.5
7	5.00	0.50	0.15	0.16	20.10	0.18						24.5
8	5.40	0.60	0.13	0.13	20.80	0.10						24.5
9	6.10	1.09	0.17	0.16	19.00	0.18						25.0
10	5.30	0.69	0.18	0.17	20.40	0.12						25.0
11	5.10	1.17	0.14	0.14	20.30	0.16						25.0
12	4.00	1.15	0.13	0.14	20.20	0.17						23.3
13	4.60	1.09	0.14	0.14	20.00	0.17						22.5
14	4.60	1.14	0.14	0.14	19.70	0.12			0.08			21.5
15	3.20	1.28	0.13	0.14	19.60	0.22						21.0
16	3.20	1.11	0.14	0.15	20.30	0.11						21.0
17	3.10	0.89	0.15	0.15	20.30	0.16						21.5
18	4.60	0.63	0.13	0.14	20.90	0.15						21.5
19	4.90	0.55	0.12	0.14	21.00	0.16						21.8
20	4.20	0.54	0.33	0.13	19.20	0.16						21.5
21	4.30	0.72	0.14	0.15	20.50	0.12						21.5
22	3.90	0.52	0.14	0.14	21.00	0.17						21.5
23	4.80	0.91	0.13	0.13	18.30	0.13						22.0
24	18.30	1.04	0.12	0.12	21.50	0.12						22.0
25	9.20	0.88	0.12	0.13	19.70	0.17						20.8
26	20.50	0.80	0.13	0.13	23.00	0.18						20.7
27	5.90	0.48	0.13	0.13	20.00	0.18						20.0
28	4.30	0.80	0.11	0.12	21.40	0.15						19.5
29	4.80	0.79	0.11	0.10	18.50	0.11						19.5
30	5.70	0.84	0.11	0.11	19.80	0.19						19.5
31												

TABLE 2.1: PARTICULATE REMOVAL PROFILE (OCT 1985)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	7.60	0.90	0.12	0.12	19.30	0.13						19.5
2	5.60	0.93	0.12	0.12	18.90	0.19						19.0
3	5.50	1.09	0.12	0.12	20.50	0.14						18.0
4	32.20	1.28	0.10	0.11	20.70	0.12						18.0
5	78.60	0.77	0.11	0.12	44.10	0.27						16.0
6	49.30	0.90	0.10	0.10	30.50	0.13						14.5
7	36.50	1.04	0.10	0.10	25.50	0.18						14.5
8	41.50	0.89	0.09	0.09	31.00	0.22						14.5
9	27.70	0.86	0.09	0.09	25.00	0.09						15.0
10	22.90	1.18	0.10	0.10	22.20	0.17						15.0
11	16.70	0.74	0.10	0.10	20.60	0.16						15.0
12	14.00	1.07	0.10	0.10	20.70	0.12						15.0
13	17.90	0.84	0.14	0.11	21.00	0.16			0.07			15.5
14	12.50	0.87	0.12	0.13	21.40	0.16						15.5
15	10.70	1.19	0.13	0.12	21.50	0.16						15.5
16	11.00	1.14	0.13	0.12	17.40	0.18						15.5
17	13.20	0.96	0.13	0.12	15.90	0.16						15.0
18	10.80	0.83	0.14	0.13	14.40	0.17						15.0
19	8.60	1.11	0.18	0.17	15.30	0.12						15.0
20	7.50	1.25	0.15	0.14	14.60	0.17						15.0
21	13.10	0.98	0.13	0.16	15.30	0.10			0.08			14.7
22	8.90	0.95	0.12	0.13	19.00	0.18						14.5
23	4.60	1.01	0.10	0.11	25.20	0.17						14.5
24	5.50	1.44	0.12	0.11	20.30	0.16						15.0
25	5.40	1.46	0.12	0.11	21.30	0.09						15.0
26	3.80	1.39	0.11	0.12	19.40	0.25			0.07			15.0
27	3.60	1.29	0.13	0.12	22.00	0.16						15.0
28	3.50	1.60	0.12	0.13	21.50	0.11						14.5
29	3.80	1.80	0.09	0.11	20.90	0.18						14.0
30	3.60	1.79	0.11	0.11	20.60	0.15						14.0
31	3.80	2.03	0.10	0.09	21.30	0.19						13.0

TABLE 2.1: PARTICULATE REMOVAL PROFILE (NOV 1985)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	6.20	1.76	0.08	0.09	21.80	0.09						13.0
2	7.80	1.72	0.11	0.10	20.20	0.25						13.0
3	6.00	1.48	0.13	0.11	22.40	0.15						13.0
4	5.20	1.71	0.15	0.14	20.90	0.21						13.0
5	3.90	1.68	0.14	0.14	19.60	0.20						12.5
6	3.70	1.56	0.16	0.15	20.70	0.10						12.0
7	8.70	1.42	0.14	0.15	20.50	0.10						12.0
8	10.40	1.74	0.17	0.15	21.20	0.17						11.0
9	6.40	1.23	0.13	0.16	20.30	0.15			0.09			11.0
10	6.30	1.10	0.13	0.13	21.00	0.18						11.0
11	5.40	1.17	0.13	0.14	23.80	0.16						10.0
12	6.70	0.84	0.13	0.16	17.20	0.23						9.5
13	4.80	0.77	0.13	0.15	19.20	0.10						9.5
14	3.90	0.76	0.13	0.14	20.10	0.18						9.5
15	3.10	0.75	0.12	0.13	19.50	0.10						9.0
16	6.60	0.92	0.14	0.14	17.90	0.26						9.0
17	20.50	0.78	0.18	0.16	19.70	0.15						8.5
18	16.30	0.90	0.19	0.19	17.10	0.10						8.2
19	29.50	1.07	0.19	0.21	19.90	0.18						9.0
20	43.90	1.28	0.15	0.17	27.00	0.23						9.2
21	26.80	1.05	0.15	0.16	25.30	0.18						8.5
22	23.40	1.00	0.15	0.15	21.20	0.20						8.0
23	23.30	0.85	0.16	0.17	21.30	0.25						7.3
24	17.00	1.02	0.16	0.17	17.60	0.13						7.3
25	12.30	1.06	0.16	0.16	17.50	0.11						6.5
26	9.60	0.82	0.16	0.18	15.20	0.10						6.5
27	11.50	0.97	0.18	0.21	15.30	0.18						6.5
28	12.70	0.99	0.18	0.21	15.80	0.12						6.5
29	15.30	0.85	0.20	0.20	17.10	0.16						6.0
30	13.70	0.67	0.21	0.20	16.20	0.14						6.0
31												

TABLE 2.1: PARTICULATE REMOVAL PROFILE (DEC 1985)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	19.40	1.56	0.18	0.18	20.50	0.22						6.0
2	99.30	3.05	0.16	0.19	45.70	0.33						4.5
3	88.80	0.76	0.12	0.14	44.30	0.33						3.3
4	71.40	0.87	0.12	0.15	37.40	0.23						3.2
5	56.30	1.01	0.14	0.16	31.90	0.28						3.0
6	42.00	0.75	0.11	0.14	30.70	0.13						3.0
7	55.50	1.27	0.14	0.16	30.30	0.28						2.8
8	72.40	0.86	0.14	0.17	48.10	0.38						2.5
9	41.10	1.21	0.15	0.17	31.90	0.10						2.5
10	35.80	1.21	0.16	0.18	27.60	0.21						2.5
11	31.70	1.10	0.15	0.20	26.80	0.23						2.5
12	34.40	1.05	0.19	0.22	24.60	0.27						2.5
13	27.50	1.29	0.18	0.20	21.40	0.11						2.5
14	51.40	2.95	0.21	0.23	25.30	0.28						2.0
15	86.20	4.60	0.21	0.26	48.50	0.27						1.0
16	67.60	5.45	0.23	0.30	49.80	0.34						0.5
17	48.30	2.40	0.21	0.21	30.00	0.27						0.5
18	38.00	1.96	0.20	0.20	27.70	0.14						0.5
19	33.80	1.90	0.21	0.24	23.70	0.27						0.5
20	30.80	1.98	0.23	0.23	22.40	0.14						0.5
21	28.30	2.05	0.24	0.26	20.00	0.27						0.5
22	26.70	1.80	0.20	0.29	20.40	0.14						0.5
23	23.30	1.80	0.23	0.24	19.50	0.13						0.5
24	18.00	1.50	0.18	0.25	20.10	0.14						0.5
25	16.30	1.60	0.20	0.25	20.50	0.14						0.5
26	15.00	1.60	0.19	0.25	20.50	0.14						0.5
27	14.00	1.70	0.15	0.23	20.60	0.14						0.5
28	11.00	1.60	0.17	0.20	20.70	0.14						0.5
29	8.90	1.40	0.15	0.18	20.50	0.28						0.5
30	8.20	1.50	0.17	0.20	16.60	0.14						0.5
31	6.90	1.40	0.18	0.21	15.30	0.14						0.5

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 2.1: PARTICULATE REMOVAL PROFILE (JAN 1986)

DATE	TURBIDITY (FTU)					COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.		mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	5.70	1.30	0.12	0.13		14.80	0.15						
2	6.30	1.90	0.13	0.12		15.60	0.15						
3	5.50	1.70	0.16	0.15		13.90	0.14						
4	4.70	1.50	0.10	0.11		15.10	0.15						
5	4.60	1.60	0.13	0.14		14.70	0.16						
6	4.50	1.90	0.11	0.10		14.60	0.13						
7	4.20	2.30	0.07	0.08		16.40	0.16						
8	4.30	2.30	0.06	0.07		15.00	0.15						
9	4.00	3.80	0.09	0.10	*	5.14	0.14						
10	3.60	2.30	0.09	0.10	*	5.31	0.13						
11	3.60	1.70	0.07	0.08	*	5.01	0.12						
12	3.10	1.40	0.18	0.17	*	6.05	0.10						
13	3.10	1.20	0.18	0.19	*	4.41	0.10						
14	3.40	1.10	0.16	0.15	*	4.09	0.11						
15	3.20	0.86	0.18	0.17	*	4.07	0.11						
16	3.10	1.20	0.16	0.15	*	4.32	0.10						
17	3.00	1.20	0.14	0.15	*	4.97	0.10						
18	3.00	0.94	0.14	0.15	*	4.39	0.11						
19	3.40	1.00	0.11	0.12	*	4.45	0.12						
20	4.30	1.10	0.12	0.13	*	5.37	0.09						
21	5.20	1.00	0.14	0.13	*	4.58	0.10			0.07			
22	6.10	1.30	0.15	0.14	*	5.07	0.10						0.5
23	4.30	1.10	0.18	0.17	*	5.09	0.11						0.5
24	3.80	1.10	0.12	0.11	*	5.01	0.10						0.5
25	4.70	1.10	0.13	0.14	*	4.97	0.10						0.5
26	3.60	1.10	0.16	0.15	*	4.35	0.12						0.5
27	3.80	1.40	0.16	0.15	*	4.92	0.12						0.5
28	3.50	1.30	0.14	0.15	*	5.21	0.10						0.5
29	3.30	1.20	0.16	0.17	*	4.86	0.10						0.5
30	3.10	1.10	0.17	0.16	*	5.01	0.12			0.08			0.5
31	3.00	1.20	0.17	0.16	*	5.00	0.11						0.5

* INDICATES POLYALUMINUM CHLORIDE

TABLE 2.1: PARTICULATE REMOVAL PROFILE (FEB 1986)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	2.80	0.97	0.12	0.14	* 4.57	0.10						0.5
2	2.70	1.00	0.14	0.15	* 4.73	0.10						0.5
3	2.70	1.00	0.14	0.12	* 5.15	0.10						0.5
4	2.70	1.00	0.10	0.11	* 4.64	0.10						0.5
5	2.80	0.98	0.11	0.14	* 4.66	0.10			0.05			0.5
6	2.90	1.10	0.13	0.15	* 5.28	0.10						0.5
7	2.00	0.79	0.08	0.10	* 4.70	0.10						0.5
8	1.40	0.66	0.08	0.08	* 4.69	0.10						0.5
9	1.60	0.64	0.09	0.10	* 4.73	0.10			0.02			0.5
10	1.50	0.63	0.08	0.09	* 5.02	0.10						0.5
11	1.40	0.63	0.07	0.09	* 5.01	0.10						0.5
12	1.20	0.63	0.10	0.09	* 5.10	0.10						0.5
13	1.20	0.81	0.08	0.09	* 5.04	0.10						0.5
14	1.30	0.53	0.08	0.07	* 4.81	0.10						0.5
15	1.50	0.60	0.07	0.09	* 5.00	0.10						0.5
16	1.70	0.61	0.09	0.09	* 5.03	0.10						0.5
17	2.00	0.85	0.10	0.09	* 5.04	0.10						0.5
18	2.10	0.87	0.10	0.09	* 4.90	0.10						0.5
19	2.00	0.75	0.10	0.10	* 5.28	0.10			0.08			0.5
20	2.00	0.64	0.09	0.10	* 4.89	0.10						0.5
21	4.80	0.85	0.12	0.11	* 5.01	0.10						0.5
22	2.60	0.74	0.10	0.12	* 5.02	0.10						0.5
23	2.40	0.79	0.10	0.12	* 5.00	0.10						0.5
24	2.90	1.10	0.11	0.13	* 4.86	0.10						0.5
25	2.70	0.89	0.10	0.10	* 5.35	0.10						0.5
26	2.60	0.87	0.10	0.12	* 4.81	0.10						0.5
27	2.50	1.00	0.09	0.10	* 5.28	0.10			0.09			0.5
28	2.60	0.86	0.11	0.12	* 5.04	0.10						0.5
29												0.5
30												0.5
31												0.5

* INDICATES POLYALUMINUM CHLORIDE

TABLE 2.1: PARTICULATE REMOVAL PROFILE (MAR 1986)

DATE	TURBIDITY (FTU)				COAGULANT		COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.		mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	2.90	0.78	0.10	0.10	*	5.05	0.08			0.08			0.5
2	2.70	0.77	0.09	0.09	*	4.70	0.07						0.5
3	2.60	0.91	0.08	0.09	*	5.26	0.11						0.5
4	3.00	0.82	0.09	0.09	*	5.01	0.06						0.5
5	2.00	0.75	0.10	0.10	*	5.15	0.11						0.5
6	1.90	0.87	0.09	0.09	*	5.14	0.05						0.5
7	1.70	0.68	0.09	0.09	*	4.64	0.12						0.5
8	1.60	0.63	0.10	0.10	*	5.02	0.07						0.5
9	1.50	0.61	0.10	0.10	*	5.02	0.07						0.5
10	1.50	0.72	0.10	0.10	*	4.67	0.08						0.5
11	10.10	1.00	0.11	0.10	*	5.00	0.07						0.5
12	3.20	0.82	0.12	0.13	*	5.07	0.08						0.5
13	1.50	0.80	0.10	0.11	*	5.61	0.08						0.5
14	2.00	0.66	0.10	0.10	*	4.79	0.08						0.5
15	2.20	0.60	0.10	0.11	*	5.37	0.07						0.5
16	2.50	0.70	0.09	0.09	*	5.00	0.07						0.5
17	1.70	0.70	0.09	0.08	*	4.99	0.11						0.5
18	1.70	0.81	0.09	0.12	*	5.08	0.10						0.5
19	2.30	1.20	0.10	0.10	*	5.03	0.07						0.5
20	3.20	1.00	0.09	0.11	*	5.17	0.10						0.5
21	4.00	1.30	0.09	0.09	*	5.29	0.10						0.5
22	2.40	0.97	0.08	0.08	*	5.60	0.08						0.5
23	6.40	1.30	0.11	0.09	*	5.05	0.07						0.5
24	6.10	1.70	0.13	0.12	*	5.18	0.06						0.5
25	5.10	1.50	0.10	0.11	*	5.24	0.09						0.5
26	8.50	2.50	0.11	0.11	*	5.59	0.10						0.5
27	11.50	1.60	0.08	0.11	*	5.86	0.08			0.04			0.7
28	9.20	1.30	0.09	0.12	*	5.94	0.07						1.0
29	18.40	1.80	0.11	0.11	*	7.10	0.07			0.07			1.0
30	5.10	1.90	0.10	0.10	*	6.16	0.07						1.0
31	4.60	1.60	0.09	0.09	*	6.22	0.11						1.0

* INDICATES POLYALUMINUM CHLORIDE

TABLE 2.1: PARTICULATE REMOVAL PROFILE (APR 1986)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	7.60	1.90	0.11	0.10	* 5.60	0.10						1.5
2	6.50	1.70	0.08	0.09	* 5.20	0.09						1.5
3	5.80	1.60	0.07	0.08	* 5.20	0.09						1.8
4	6.10	2.02	0.06	0.08	16.50	0.14						2.0
5	4.80	1.68	0.06	0.08	20.80	0.06						2.5
6	6.80	1.98	0.08	0.09	24.00	0.13						2.5
7	9.10	2.88	0.09	0.09	17.80	0.10						2.5
8	12.50	3.54	0.08	0.09	17.90	0.15						5.0
9	10.40	3.14	0.08	0.08	26.80	0.11			0.04			5.5
10	7.00	2.53	0.08	0.08	23.00	0.16						5.0
11	9.50	2.90	0.08	0.09	21.80	0.10						5.0
12	9.60	2.65	0.10	0.10	19.20	0.13						5.0
13	9.10	2.75	0.07	0.09	20.70	0.13						5.5
14	9.60	2.80	0.09	0.09	20.50	0.10						5.5
15	20.20	4.15	0.07	0.09	20.90	0.18						6.5
16	13.30	3.25	0.09	0.10	20.70	0.09						6.5
17	8.80	2.15	0.08	0.08	20.40	0.09						6.5
18	10.60	2.55	0.09	0.08	17.90	0.20						7.0
19	8.20	2.19	0.09	0.09	20.60	0.10						7.5
20	5.30	1.44	0.09	0.09	19.00	0.13						8.0
21	2.40	1.58	0.09	0.09	19.30	0.11						8.0
22	6.50	1.86	0.07	0.08	22.00	0.10						8.0
23	6.10	1.82	0.08	0.08	21.90	0.18						8.0
24	4.70	1.31	0.07	0.08	20.50	0.17						8.0
25	8.10	1.63	0.09	0.08	21.30	0.10						9.0
26	3.80	1.25	0.08	0.09	20.10	0.10			0.13			10.0
27	2.70	0.71	0.08	0.08	21.30	0.12						10.5
28	3.50	0.67	0.07	0.08	20.00	0.16						10.5
29	11.30	1.20	0.08	0.08	20.70	0.14						11.5
30	4.30	0.57	0.07	0.08	21.40	0.08						11.5
31												

* INDICATES POLYALUMINUM CHLORIDE

TABLE 2.1: PARTICULATE REMOVAL PROFILE (MAY 1986)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	8.80	0.96	0.09	0.09	23.60	0.16						12.0
2	5.90	0.71	0.09	0.08	26.00	0.14						12.0
3	3.50	0.83	0.09	0.09	18.70	0.09						11.5
4	3.30	0.67	0.10	0.09	18.60	0.12						11.5
5	7.10	0.71	0.10	0.11	20.70	0.16						12.0
6	6.50	0.77	0.12	0.12	22.10	0.14						12.0
7	10.30	0.99	0.12	0.12	20.30	0.13						12.5
8	9.60	0.91	0.14	0.12	20.50	0.14						14.0
9	6.40	0.94	0.12	0.12	20.30	0.14						14.5
10	6.10	0.69	0.11	0.11	22.30	0.16						14.0
11	4.20	0.78	0.11	0.11	20.50	0.08						14.5
12	3.90	0.71	0.11	0.10	19.10	0.13						15.5
13	3.60	0.64	0.11	0.11	20.10	0.12						15.0
14	3.40	0.44	0.10	0.11	19.00	0.14						15.0
15	4.10	0.60	0.10	0.09	21.90	0.13						15.0
16	8.50	0.67	0.12	0.11	21.10	0.14						16.0
17	4.80	0.40	0.11	0.11	20.00	0.09						16.0
18	4.40	0.67	0.12	0.12	18.90	0.11						16.0
19	5.90	0.61	0.13	0.12	20.80	0.13			0.10			16.0
20	6.40	0.83	0.11	0.12	20.20	0.18						15.5
21	6.00	0.85	0.10	0.11	21.30	0.14						15.5
22	5.10	0.58	0.09	0.09	21.90	0.09						15.5
23	5.70	0.73	0.11	0.11	20.50	0.07						15.5
24	4.90	0.54	0.11	0.11	21.60	0.09			0.12			15.5
25	3.50	0.59	0.11	0.11	17.30	0.15						15.5
26	4.30	1.00	0.12	0.11	19.90	0.08						16.5
27	2.70	0.46	0.10	0.10	20.80	0.08						17.0
28	2.70	0.33	0.10	0.11	20.50	0.14						17.5
29	3.00	0.33	0.10	0.10	20.40	0.14						17.5
30	3.80	0.32	0.09	0.09	19.00	0.15						18.0
31	3.60	0.33	0.09	0.10	23.70	0.14						17.5

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 2.1: PARTICULATE REMOVAL PROFILE (JUN 1986)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	3.70	0.65	0.10	0.09	20.00	0.10						17.5
2	4.30	1.04	0.09	0.10	21.50	0.08						17.5
3	9.30	1.12	0.10	0.08	19.50	0.15						17.5
4	5.30	0.60	0.10	0.11	20.90	0.14						18.0
5	5.00	0.39	0.11	0.11	20.90	0.07						18.0
6	4.50	0.71	0.09	0.10	20.90	0.09						18.0
7	4.50	0.35	0.10	0.10	19.90	0.11						18.0
8	5.40	0.29	0.10	0.10	19.20	0.11						18.5
9	4.70	0.72	0.09	0.09	20.40	0.17						19.0
10	4.30	0.56	0.09	0.09	20.80	0.08						19.0
11	4.40	0.33	0.09	0.10	22.10	0.18						19.5
12	46.60	0.91	0.12	0.10	27.80	0.16						20.0
13	82.80	1.16	0.17	0.13	36.50	0.23						20.0
14	29.20	0.73	0.15	0.18	24.00	0.20						20.0
15	28.50	0.82	0.18	0.16	26.10	0.13						20.0
16	42.80	1.47	0.18	0.18	25.00	0.09						20.5
17	21.00	1.39	0.11	0.15	24.80	0.16						20.8
18	20.50	1.48	0.14	0.12	22.30	0.15						21.0
19	19.30	1.14	0.13	0.13	19.20	0.16						21.0
20	17.20	0.91	0.12	0.12	17.96	0.16						21.0
21	14.50	0.89	0.11	0.12	21.80	0.10						21.0
22	7.70	0.78	0.11	0.12	19.00	0.13			0.12			22.0
23	16.60	1.11	0.16	0.13	20.50	0.14						22.0
24	11.60	0.79	0.11	0.11	17.50	0.14						21.5
25	10.90	0.68	0.08	0.08	21.00	0.15						21.5
26	14.60	1.02	0.08	0.08	21.80	0.14						22.0
27	26.40	0.55	0.11	0.10	22.40	0.14				8.04	7.34	22.0
28	13.00	0.43	0.09	0.10	20.30	0.18						22.5
29	12.00	0.56	0.07	0.08	20.60	0.17						22.5
30	11.00	0.97	0.70	0.07	20.30	0.09			0.06	7.73	7.38	22.5
31												

TABLE 2.1: PARTICULATE REMOVAL PROFILE (JUL 1986)

DATE	TURBIDITY (FTU)				COAGULANT	COAG. AID	FILTER AID	METAL RES. Al (mg/L)		pH		TEMP DEG. C.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	10.60	0.81	0.60	0.06	20.90	0.19				8.12	7.61	21.5
2	11.90	0.68	0.06	0.06	19.70	0.16				8.16	7.63	21.8
3	11.90	1.00	0.06	0.06	20.40	0.14				8.24	7.53	21.5
4	15.50	1.33	0.08	0.06	19.90	0.20						22.0
5	18.70	0.88	0.11	0.10	20.70	0.12						22.5
6	8.40	0.57	0.09	0.09	21.30	0.20						22.5
7	7.20	0.52	0.07	0.08	21.40	0.11						22.5
8	7.50	1.14	0.06	0.07	20.80	0.18						22.5
9	8.90	0.64	0.06	0.07	21.60	0.14			0.10			22.5
10	6.80	1.40	0.07	0.06	21.30	0.21						23.0
11	6.00	0.95	0.07	0.07	20.80	0.08						23.0
12	9.40	0.49	0.07	0.07	19.80	0.17						23.0
13	8.10	0.63	0.07	0.08	19.70	0.12						23.0
14	10.00	1.01	0.07	0.08	19.60	0.15						24.0
15	7.70	1.18	0.08	0.08	20.50	0.20						24.0
16	5.80	0.84	0.09	0.09	20.30	0.12						24.5
17	4.80	0.82	0.09	0.10	20.30	0.13			0.12			25.0
18	4.60	0.45	0.08	0.09	20.20	0.15						25.0
19	4.50	0.36	0.08	0.08	22.10	0.12						24.0
20	3.60	0.27	0.07	0.08	22.20	0.17			0.09			24.0
21	3.90	1.79	0.07	0.07	20.20	0.13						24.0
22	3.70	0.98	0.08	0.07	20.30	0.16						25.0
23	4.60	0.61	0.08	0.08	20.10	0.15						26.2
24	5.50	0.92	0.12	0.11	21.60	0.14						26.2
25	4.90	0.98	0.13	0.11	21.80	0.17						27.5
26	10.60	0.47	0.11	0.09	18.40	0.14						26.2
27	10.60	0.83	0.12	0.09	20.30	0.09						25.0
28	5.70	0.67	0.16	0.10	19.20	0.17						26.5
29	4.20	0.85	0.14	0.13	19.80	0.17						26.5
30	3.60	0.80	0.09	0.09	21.10	0.15			0.14	8.32	7.75	26.5
31	3.00	0.81	0.11	0.09	20.00	0.14				8.40	7.55	27.0

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 3.0: DISINFECTION SUMMARY

		1986						1985						1984						1983					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JAN	Cl2 Demand																								
	Cl2 Dosage	0.82	0.41	0.59	0.66	0.39	0.52	1.30	0.87	1.07	0.42	0.26	0.33	1.02	0.66	0.88	0.29	0.24	0.27						
	Ammonia																								
	SO2																								
	Resid. Cl2 Free																								
	Resid. Cl2 Comb.																								
	Resid. Cl2 Total	0.24	0.21	0.23	0.78	0.73	0.76	0.19	0.14	0.17	0.75	0.54	0.66	0.31	0.16	0.23	0.75	0.58	0.67						
FEB	Cl2 Demand																								
	Cl2 Dosage	0.80	0.46	0.58	0.58	0.43	0.51	1.10	0.74	0.93	0.35	0.24	0.29	1.50	0.66	0.93	0.46	0.20	0.29						
	Ammonia																								
	SO2																								
	Resid. Cl2 Free																								
	Resid. Cl2 Comb.																								
	Resid. Cl2 Total	0.24	0.21	0.22	0.95	0.65	0.77	0.22	0.16	0.19	0.75	0.58	0.66	0.29	0.16	0.22	0.79	0.50	0.67						
MAR	Cl2 Demand																								
	Cl2 Dosage	0.68	0.50	0.59	0.57	0.41	0.50	1.65	0.82	1.12	0.46	0.26	0.35	1.80	0.82	1.32	0.51	0.27	0.40						
	Ammonia																								
	SO2																								
	Resid. Cl2 Free																								
	Resid. Cl2 Comb.																								
	Resid. Cl2 Total	0.25	0.21	0.23	1.00	0.65	0.77	0.24	0.14	0.18	0.78	0.55	0.66	0.29	0.22	0.25	0.75	0.58	0.67						

TABLE 3.0: DISINFECTION SUMMARY

		1986						1985						1984						1983					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
APR	Cl2 Demand																								
	Cl2 Dosage	0.71	0.51	0.60	0.61	0.39	0.52	2.66	0.98	1.70	0.80	0.31	0.52	1.80	1.30	1.48	0.52	0.38	0.43						
	Ammonia																								
	SO2																								
	Resid. Cl2 Free																								
	Resid. Cl2 Comb.																								
	Resid. Cl2 Total	0.76	0.22	0.27	0.90	0.60	0.76	0.25	0.16	0.20	0.81	0.56	0.68	0.32	0.15	0.23	0.72	0.59	0.67						
MAY	Cl2 Demand																								
	Cl2 Dosage	0.80	0.55	0.62	0.70	0.47	0.54	1.90	0.53	0.86	0.65	0.47	0.55	3.30	0.93	2.03	0.93	0.26	0.58						
	Ammonia																								
	SO2																								
	Resid. Cl2 Free																								
	Resid. Cl2 Comb.																								
	Resid. Cl2 Total	0.27	0.22	0.24	0.82	0.60	0.76	0.31	0.14	0.26	0.73	0.59	0.66	0.32	0.12	0.20	0.74	0.58	0.66						
JUN	Cl2 Demand																								
	Cl2 Dosage	0.71	0.50	0.63	0.68	0.46	0.54	0.67	0.53	0.61	0.65	0.46	0.52	3.10	2.20	2.63	1.10	0.72	0.83						
	Ammonia																								
	SO2																								
	Resid. Cl2 Free																								
	Resid. Cl2 Comb.																								
	Resid. Cl2 Total	0.27	0.20	0.24	0.85	0.62	0.76	0.31	0.27	0.29	0.79	0.58	0.67	0.27	0.16	0.22	0.75	0.60	0.66						

TABLE 3.0: DISINFECTION SUMMARY

		1986						1985						1984						1983					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JUL	Cl2 Demand																								
	Cl2 Dosage	0.72	0.50	0.59	0.66	0.38	0.52	0.70	0.52	0.61	0.61	0.48	0.53	4.30	2.40	2.97	1.40	0.74	0.94						
	Ammonia																								
	SO2																								
	Resid. Cl2 Free																								
	Resid. Cl2 Comb.																								
	Resid. Cl2 Total	0.27	0.21	0.23	0.89	0.55	0.77	0.32	0.27	0.29	0.86	0.53	0.72	0.37	0.15	0.26	0.75	0.58	0.67						
AUG	Cl2 Demand																								
	Cl2 Dosage							0.71	0.56	0.64	0.63	0.51	0.57	4.70	2.10	3.04	1.50	0.68	0.98	4.30	2.10	2.92	1.20	0.70	0.92
	Ammonia																								
	SO2																								
	Resid. Cl2 Free																								
	Resid. Cl2 Comb.																								
	Resid. Cl2 Total							0.30	0.26	0.28	0.85	0.60	0.77	0.49	0.19	0.30	0.75	0.50	0.66	0.21	0.14	0.17	0.74	0.56	0.65
SEP	Cl2 Demand																								
	Cl2 Dosage							0.74	0.55	0.61	0.60	0.49	0.53	4.84	2.28	2.79	1.33	0.70	0.88	3.50	2.00	2.65	1.10	0.68	0.83
	Ammonia																								
	SO2																								
	Resid. Cl2 Free																								
	Resid. Cl2 Comb.																								
	Resid. Cl2 Total							0.31	0.26	0.28	0.85	0.60	0.77	0.42	0.23	0.30	0.94	0.59	0.73	0.17	0.01	0.15	0.72	0.58	0.66

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 3.0: DISINFECTION SUMMARY

		1986						1985						1984						1983					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
OCT	Cl2 Demand																								
	Cl2 Dosage	0.00	0.00	0.00				0.73	0.47	0.61	0.63	0.46	0.52	3.53	1.52	2.16	0.93	0.48	0.67	4.40	1.00	2.16	1.40	0.34	0.68
	Ammonia																								
	SO2																								
	Resid. Cl2 Free	0.00	0.00	0.00	0.00	0.00	0.00																		
	Resid. Cl2 Comb.																								
	Resid. Cl2 Total							0.31	0.23	0.28	0.90	0.61	0.77	0.38	0.21	0.30	0.85	0.60	0.76	0.25	0.06	0.15	0.80	0.50	0.68
NOV	Cl2 Demand																								
	Cl2 Dosage	0.00	0.00	0.00				0.87	0.49	0.64	0.74	0.45	0.54	2.46	1.21	1.68	0.69	0.35	0.50	2.00	1.20	1.55	0.67	0.35	0.48
	Ammonia																								
	SO2																								
	Resid. Cl2 Free	0.00	0.00	0.00	0.00	0.00	0.00																		
	Resid. Cl2 Comb.																								
	Resid. Cl2 Total							0.30	0.26	0.28	0.90	0.60	0.77	0.37	0.15	0.25	0.85	0.55	0.71	0.21	0.12	0.15	0.71	0.54	0.65
DEC	Cl2 Demand																								
	Cl2 Dosage	0.00	0.00	0.00				0.79	0.56	0.64	0.66	0.44	0.55	2.56	0.88	1.36	0.52	0.29	0.39	2.40	0.70	1.43	0.69	0.20	0.45
	Ammonia																								
	SO2																								
	Resid. Cl2 Free	0.00	0.00	0.00	0.00	0.00	0.00																		
	Resid. Cl2 Comb.																								
	Resid. Cl2 Total							0.30	0.22	0.28	0.78	0.72	0.76	0.19	0.14	0.16	0.77	0.56	0.66	0.20	0.14	0.16	0.74	0.50	0.65

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 3.1: DISINFECTION PROFILE (AUG 1983)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		4.30					0.16		1.20					0.65	1
2		3.40					0.20		1.10					0.66	2
3		2.90					0.21		0.93					0.66	3
4		2.70					0.19		0.82					0.65	4
5		2.50					0.19		0.83					0.64	5
6		3.00					0.17		0.96					0.64	6
7		3.50					0.15		1.10					0.65	7
8		2.90					0.18		0.99					0.65	8
9		3.80					0.17		1.10					0.65	9
10		3.10					0.18		1.00					0.65	10
11		3.50					0.19		1.10					0.65	11
12		3.30					0.16		1.00					0.65	12
13		3.40					0.17		1.20					0.64	13
14		3.80					0.18		1.10					0.65	14
15		3.60					0.17		1.10					0.64	15
16		2.90					0.21		0.94					0.65	16
17		2.50					0.17		0.79					0.66	17
18		2.20					0.15		0.80					0.67	18
19		2.40					0.15		0.70					0.66	19
20		2.30					0.15		0.70					0.66	20
21		2.10					0.15		0.76					0.67	21
22		2.50					0.17		0.76					0.65	22
23		2.70					0.16		0.82					0.66	23
24		2.60					0.16		0.83					0.65	24
25		2.60					0.17		0.80					0.66	25
26		2.60					0.16		0.76					0.66	26
27		2.70					0.15		0.89					0.65	27
28		2.80					0.14		0.82					0.65	28
29		2.70					0.15		0.85					0.65	29
30		2.50					0.16		0.82					0.66	30
31		2.70					0.15		0.88					0.65	31

TABLE 3.1: DISINFECTION PROFILE (SEP 1983)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		2.60					0.16		0.79					0.66	1
2		2.50					0.15		0.75					0.65	2
3		2.30					0.14		0.71					0.65	3
4		2.40					0.15		0.73					0.65	4
5		2.70					0.14		0.81					0.65	5
6		2.30					0.14		0.82					0.63	6
7		2.70					0.14		0.88					0.65	7
8		2.70					0.15		0.86					0.66	8
9		2.60					0.16		0.79					0.66	9
10		2.40					0.16		0.74					0.66	10
11		2.70					0.14		0.90					0.65	11
12		2.70					0.15		0.86					0.65	12
13		2.60					0.15		0.81					0.65	13
14		2.60					0.16		0.83					0.66	14
15		3.00					0.17		0.73					0.67	15
16		2.20					0.14		0.72					0.64	16
17		3.10					0.14		1.10					0.65	17
18		3.50					0.13		1.00					0.67	18
19		2.90					0.16		0.92					0.66	19
20		2.60					0.16		0.83					0.65	20
21		2.70					0.14		0.86					0.65	21
22		3.00					0.01		0.91					0.66	22
23		2.30					0.16		0.75					0.66	23
24		3.00					0.14		1.00					0.65	24
25		3.20					0.14		0.87					0.66	25
26		2.60					0.17		0.87					0.66	26
27		2.20					0.15		0.68					0.66	27
28		2.80					0.14		0.77					0.66	28
29		2.20					0.17		0.75					0.66	29
30		2.50					0.16		0.74					0.68	30
31															31

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 3.1: DISINFECTION PROFILE (OCT 1983)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		2.10					0.15		0.75					0.69	1
2		2.00					0.12		0.55					0.72	2
3		1.70					0.10		0.55					0.68	3
4		1.30					0.09		0.39					0.72	4
5		1.00					0.06		0.34					0.69	5
6		2.20					0.08		0.75					0.69	6
7		4.00					0.12		1.20					0.69	7
8		4.10					0.14		1.40					0.67	8
9		4.40					0.14		1.40					0.67	9
10		3.50					0.18		1.00					0.70	10
11		2.90					0.17		0.90					0.70	11
12		2.60					0.15		0.83					0.70	12
13		2.30					0.16		0.73					0.69	13
14		2.20					0.15		0.66					0.69	14
15		2.80					0.17		0.80					0.73	15
16		2.50					0.24		0.79					0.73	16
17		1.70					0.25		0.57					0.70	17
18		1.70					0.20		0.50					0.66	18
19		1.50					0.17		0.49					0.66	19
20		1.40					0.14		0.43					0.65	20
21		1.70					0.14		0.48					0.65	21
22		1.40					0.15		0.51					0.66	22
23		1.70					0.13		0.59					0.64	23
24		1.60					0.15		0.46					0.65	24
25		1.60					0.14		0.53					0.66	25
26		1.90					0.15		0.51					0.66	26
27		1.60					0.14		0.51					0.65	27
28		1.90					0.13		0.54					0.67	28
29		1.80					0.13		0.64					0.65	29
30		2.10					0.11		0.64					0.65	30
31		1.80					0.15		0.58					0.65	31

TABLE 3.1: DISINFECTION PROFILE (NOV 1983)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		2.00					0.16		0.56					0.65	1
2		1.50					0.15		0.52					0.65	2
3		1.80					0.14		0.55					0.64	3
4		1.60					0.16		0.53					0.65	4
5		1.80					0.16		0.60					0.65	5
6		1.90					0.16		0.67					0.65	6
7		1.90					0.21		0.53					0.65	7
8		1.40					0.16		0.43					0.67	8
9		1.40					0.17		0.44					0.65	9
10		1.20					0.16		0.41					0.66	10
11		1.40					0.17		0.53					0.65	11
12		1.40					0.17		0.48					0.65	12
13		1.60					0.16		0.40					0.65	13
14		1.20					0.17		0.39					0.64	14
15		1.30					0.17		0.37					0.64	15
16		1.20					0.15		0.35					0.64	16
17		1.20					0.14		0.37					0.64	17
18		1.30					0.14		0.41					0.65	18
19		1.50					0.15		0.50					0.65	19
20		1.50					0.16		0.41					0.64	20
21		2.00					0.15		0.49					0.65	21
22		1.50					0.15		0.47					0.66	22
23		1.60					0.16		0.47					0.65	23
24		1.30					0.15		0.39					0.64	24
25		1.60					0.12		0.43					0.66	25
26		1.60					0.12		0.52					0.63	26
27		1.60					0.15		0.56					0.66	27
28		1.70					0.14		0.41					0.65	28
29		1.60					0.16		0.53					0.64	29
30		1.80					0.13		0.59					0.65	30
31															31

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 3.1: DISINFECTION PROFILE (DEC 1983)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		2.00					0.15		0.54					0.66	1
2		2.00					0.16		0.68					0.64	2
3		2.10					0.15		0.68					0.65	3
4		2.40					0.14		0.55					0.65	4
5		1.80					0.16		0.49					0.65	5
6		1.30					0.15		0.54					0.65	6
7		1.70					0.14		0.54					0.65	7
8		1.80					0.14		0.52					0.65	8
9		2.10					0.15		0.52					0.65	9
10		1.70					0.15		0.66					0.67	10
11		2.10					0.14		0.69					0.66	11
12		1.80					0.15		0.50					0.65	12
13		1.90					0.15		0.49					0.65	13
14		1.50					0.18		0.50					0.65	14
15		1.30					0.16		0.36					0.65	15
16		1.80					0.14		0.57					0.64	16
17		1.60					0.14		0.53					0.65	17
18		1.20					0.18		0.53					0.66	18
19		0.89					0.16		0.37					0.64	19
20		1.20					0.15		0.44					0.64	20
21		0.90					0.17		0.30					0.65	21
22		0.88					0.15		0.30					0.63	22
23		0.90					0.16		0.27					0.64	23
24		1.07					0.15		0.31					0.64	24
25		1.07					0.17		0.33					0.66	25
26		1.10					0.15		0.30					0.65	26
27		0.70					0.15		0.20					0.64	27
28		0.90					0.20		0.30					0.63	28
29		0.86					0.16		0.29					0.67	29
30		0.81					0.17		0.25					0.67	30
31		1.00					0.20		0.31					0.67	31

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 3.1: DISINFECTION PROFILE (JAN 1984)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		0.80					0.19		0.26					0.68	1
2		0.98					0.16		0.27					0.67	2
3		0.99					0.26		0.28					0.67	3
4		0.94					0.30		0.29					0.69	4
5		0.96					0.30		0.26					0.69	5
6		0.80					0.28		0.25					0.66	6
7		0.89					0.20		0.26					0.67	7
8		0.80					0.18		0.27					0.67	8
9		0.94					0.24		0.28					0.66	9
10		0.92					0.26		0.26					0.68	10
11		0.86					0.31		0.28					0.68	11
12		0.94					0.27		0.28					0.69	12
13		1.00					0.28		0.28					0.68	13
14		0.78					0.25		0.28					0.67	14
15		0.68					0.21		0.25					0.67	15
16		0.83					0.24		0.25					0.66	16
17		0.86					0.26		0.27					0.68	17
18		0.98					0.23		0.27					0.65	18
19		0.85					0.24		0.26					0.67	19
20		1.02					0.18		0.28					0.67	20
21		0.80					0.21		0.24					0.67	21
22		0.86					0.19		0.29					0.66	22
23		0.97					0.23		0.29					0.67	23
24		0.85					0.27		0.25					0.70	24
25		0.88					0.27		0.26					0.69	25
26		0.91					0.23		0.26					0.67	26
27		0.81					0.23		0.26					0.66	27
28		0.91					0.18		0.28					0.65	28
29		0.66					0.16		0.27					0.66	29
30		0.97					0.24		0.29					0.67	30
31		0.86					0.22		0.26					0.68	31

TABLE 3.1: DISINFECTION PROFILE (FEB 1984)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		0.88					0.21		0.25					0.67	1
2		0.89					0.26		0.27					0.68	2
3		0.97					0.23		0.28					0.68	3
4		0.74					0.18		0.24					0.67	4
5		0.73					0.17		0.28					0.67	5
6		0.90					0.21		0.28					0.66	6
7		0.90					0.22		0.27					0.66	7
8		0.96					0.22		0.28					0.68	8
9		0.97					0.22		0.30					0.65	9
10		0.86					0.20		0.26					0.67	10
11		0.82					0.18		0.28					0.67	11
12		0.66					0.16		0.26					0.67	12
13		0.90					0.20		0.28					0.67	13
14		0.94					0.19		0.27					0.67	14
15		1.04					0.25		0.29					0.66	15
16		0.80					0.29		0.26					0.67	16
17		0.68					0.20		0.20					0.66	17
18		0.76					0.16		0.27					0.67	18
19		0.90					0.17		0.28					0.67	19
20		1.00					0.20		0.28					0.65	20
21		1.10					0.23		0.28					0.67	21
22		0.84					0.28		0.29					0.67	22
23		0.86					0.28		0.27					0.66	23
24		0.88					0.28		0.26					0.66	24
25		1.00					0.29		0.36					0.69	25
26		1.30					0.27		0.33					0.68	26
27		1.10					0.25		0.33					0.68	27
28		1.20					0.20		0.35					0.70	28
29		1.50					0.28		0.46					0.69	29
30															30
31															31

TABLE 3.1: DISINFECTION PROFILE (MAR 1984)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		1.30					0.26		0.40					0.68	1
2		1.20					0.25		0.38					0.67	2
3		0.82					0.25		0.29					0.66	3
4		0.98					0.24		0.39					0.67	4
5		1.30					0.25		0.41					0.67	5
6		1.20					0.24		0.35					0.68	6
7		1.30					0.26		0.40					0.69	7
8		1.10					0.28		0.35					0.68	8
9		1.30					0.22		0.27					0.67	9
10		1.10					0.24		0.48					0.67	10
11		1.30					0.27		0.50					0.66	11
12		1.40					0.25		0.36					0.67	12
13		1.30					0.26		0.37					0.68	13
14		1.30					0.26		0.38					0.67	14
15		1.30					0.25		0.38					0.66	15
16		1.40					0.26		0.39					0.67	16
17		1.40					0.27		0.50					0.67	17
18		1.50					0.25		0.43					0.67	18
19		1.50					0.29		0.41					0.68	19
20		1.30					0.26		0.40					0.67	20
21		1.30					0.25		0.41					0.67	21
22		1.80					0.23		0.36					0.67	22
23		1.40					0.24		0.37					0.66	23
24		1.60					0.23		0.43					0.66	24
25		1.40					0.25		0.51					0.66	25
26		1.60					0.26		0.42					0.68	26
27		1.40					0.25		0.38					0.68	27
28		1.20					0.29		0.36					0.68	28
29		1.20					0.25		0.42					0.67	29
30		1.30					0.26		0.41					0.66	30
31		1.40					0.22		0.44					0.68	31

TABLE 3.1: DISINFECTION PROFILE (APR 1984)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		1.79					0.23		0.50					0.66	1
2		1.50					0.29		0.45					0.68	2
3		1.50					0.25		0.45					0.67	3
4		1.30					0.27		0.40					0.68	4
5		1.30					0.28		0.42					0.68	5
6		1.30					0.29		0.42					0.69	6
7		1.30					0.25		0.42					0.67	7
8		1.30					0.24		0.43					0.66	8
9		1.50					0.25		0.40					0.67	9
10		1.30					0.25		0.38					0.68	10
11		1.60					0.28		0.47					0.68	11
12		1.50					0.30		0.42					0.66	12
13		1.50					0.32		0.41					0.67	13
14		1.40					0.28		0.45					0.68	14
15		1.70					0.23		0.44					0.66	15
16		1.50					0.26		0.41					0.67	16
17		1.30					0.27		0.41					0.66	17
18		1.30					0.22		0.40					0.67	18
19		1.40					0.21		0.41					0.66	19
20		1.60					0.23		0.52					0.67	20
21		1.80					0.19		0.48					0.66	21
22		1.70					0.21		0.44					0.66	22
23		1.80					0.23		0.47					0.67	23
24		1.50					0.22		0.42					0.68	24
25		1.30					0.19		0.39					0.65	25
26		1.30					0.16		0.40					0.66	26
27		1.50					0.15		0.40					0.64	27
28		1.50					0.16		0.48					0.66	28
29		1.50					0.17		0.44					0.65	29
30		1.50					0.15		0.42					0.64	30
31															31

TABLE 3.1: DISINFECTION PROFILE (MAY 1984)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		1.70					0.15		0.55					0.65	1
2		2.10					0.15		0.57					0.64	2
3		1.80					0.17		0.55					0.68	3
4		1.90					0.17		0.60					0.66	4
5		2.10					0.15		0.58					0.67	5
6		2.00					0.16		0.61					0.66	6
7		1.90					0.19		0.59					0.66	7
8		1.80					0.16		0.51					0.67	8
9		1.08					0.32		0.32					0.65	9
10		0.94					0.25		0.29					0.64	10
11		0.93					0.17		0.26					0.64	11
12		1.06					0.18		0.26					0.65	12
13		1.11					0.16		0.31					0.64	13
14		1.20					0.14		0.36					0.65	14
15		1.10					0.16		0.34					0.64	15
16		1.30					0.13		0.34					0.65	16
17		2.10					0.12		0.39					0.67	17
18		2.90					0.18		0.65					0.68	18
19		2.40					0.23		0.80					0.67	19
20		3.10					0.23		0.89					0.67	20
21		2.70					0.23		0.83					0.67	21
22		2.20					0.26		0.81					0.67	22
23		2.50					0.20		0.68					0.67	23
24		2.40					0.22		0.73					0.65	24
25		2.40					0.24		0.74					0.67	25
26		2.70					0.20		0.80					0.68	26
27		3.19					0.19		0.93					0.67	27
28		2.50					0.27		0.74					0.68	28
29		3.30					0.25		0.73					0.67	29
30		2.20					0.21		0.63					0.67	30
31		2.30					0.22		0.68					0.67	31

TABLE 3.1: DISINFECTION PROFILE (JUN 1984)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		2.50					0.23		0.74					0.66	1
2		2.40					0.18		0.75					0.66	2
3		2.60					0.19		0.83					0.65	3
4		2.40					0.23		0.72					0.65	4
5		2.40					0.22		0.73					0.67	5
6		2.50					0.22		0.81					0.67	6
7		2.75					0.17		0.85					0.66	7
8		2.96					0.21		0.92					0.68	8
9		3.02					0.20		0.86					0.66	9
10		3.03					0.22		0.99					0.66	10
11		2.50					0.25		0.83					0.68	11
12		2.50					0.27		0.75					0.67	12
13		2.20					0.26		0.73					0.66	13
14		2.30					0.22		0.74					0.65	14
15		2.80					0.22		0.85					0.65	15
16		2.80					0.20		0.83					0.65	16
17		2.70					0.22		0.97					0.67	17
18		2.60					0.26		0.81					0.67	18
19		2.80					0.25		0.81					0.67	19
20		2.50					0.24		0.80					0.66	20
21		2.50					0.23		0.76					0.66	21
22		2.30					0.24		0.76					0.65	22
23		2.50					0.20		0.75					0.65	23
24		3.10					0.16		1.10					0.64	24
25		2.70					0.25		0.84					0.66	25
26		2.60					0.26		0.81					0.67	26
27		2.90					0.23		0.93					0.66	27
28		2.70					0.22		0.83					0.66	28
29		2.70					0.24		0.85					0.66	29
30		2.70					0.21		0.82					0.67	30
31															31

TABLE 3.1: DISINFECTION PROFILE (JUL 1984)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		2.90					0.21		0.91					0.65	1
2		2.80					0.23		0.87					0.65	2
3		2.50					0.23		0.79					0.67	3
4		2.60					0.18		0.78					0.66	4
5		2.60					0.16		0.81					0.65	5
6		3.70					0.16		1.09					0.65	6
7		2.90					0.15		0.98					0.65	7
8		3.50					0.16		1.07					0.66	8
9		2.40					0.17		0.74					0.67	9
10		2.90					0.17		0.88					0.65	10
11		2.40					0.17		0.77					0.66	11
12		2.80					0.22		0.91					0.66	12
13		2.80					0.25		0.81					0.66	13
14		2.80					0.23		0.88					0.67	14
15		3.00					0.21		0.97					0.68	15
16		3.20					0.25		1.00					0.66	16
17		3.40					0.27		1.00					0.67	17
18		3.30					0.29		1.20					0.67	18
19		3.30					0.37		1.00					0.70	19
20		4.30					0.37		1.40					0.67	20
21		2.60					0.32		0.86					0.68	21
22		3.20					0.33		1.10					0.69	22
23		2.50					0.32		0.79					0.68	23
24		2.50					0.37		0.84					0.69	24
25		2.50					0.34		0.85					0.67	25
26		2.90					0.33		0.99					0.66	26
27		3.20					0.31		1.00					0.67	27
28		3.40					0.26		1.10					0.65	28
29		3.60					0.27		1.10					0.65	29
30		2.90					0.36		0.90					0.67	30
31		2.60					0.31		0.88					0.65	31

TABLE 3.1: DISINFECTION PROFILE (AUG 1984)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		2.70					0.34		0.87					0.66	1
2		2.40					0.32		0.78					0.67	2
3		3.10					0.31		1.02					0.66	3
4		3.76					0.29		1.24					0.67	4
5		4.70					0.44		1.43					0.67	5
6		3.40					0.49		1.10					0.70	6
7		2.80					0.31		0.81					0.65	7
8		3.10					0.34		1.00					0.66	8
9		2.90					0.30		0.91					0.64	9
10		2.70					0.30		0.90					0.65	10
11		3.20					0.24		0.95					0.65	11
12		3.40					0.22		1.20					0.65	12
13		3.70					0.21		1.20					0.66	13
14		3.70					0.24		1.30					0.67	14
15		3.30					0.30		1.10					0.67	15
16		3.10					0.29		0.98					0.67	16
17		3.00					0.32		0.99					0.65	17
18		3.10					0.27		0.98					0.65	18
19		4.70					0.19		1.50					0.64	19
20		3.30					0.31		1.10					0.66	20
21		2.90					0.37		0.95					0.67	21
22		2.50					0.33		0.78					0.72	22
23		2.70					0.34		0.88					0.68	23
24		2.70					0.30		0.83					0.64	24
25		2.70					0.32		0.88					0.67	25
26		3.20					0.37		1.10					0.63	26
27		2.10					0.26		0.68					0.63	27
28		2.20					0.26		0.70					0.66	28
29		2.20					0.21		0.68					0.66	29
30		2.30					0.23		0.71					0.67	30
31		2.80					0.23		0.88					0.66	31

TABLE 3.1: DISINFECTION PROFILE (SEP 1984)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		3.14					0.28		0.99					0.65	1
2		3.79					0.31		1.33					0.67	2
3		2.84					0.29		0.88					0.68	3
4		2.85					0.29		0.94					0.65	4
5		3.24					0.30		1.01					0.64	5
6		2.37					0.33		0.79					0.68	6
7		2.36					0.28		0.73					0.66	7
8		3.12					0.23		0.99					0.64	8
9		2.80					0.23		0.85					0.65	9
10		2.84					0.30		0.93					0.67	10
11		2.56					0.35		0.82					0.65	11
12		2.68					0.32		0.83					0.72	12
13		2.64					0.33		0.83					0.83	13
14		2.34					0.26		0.74					0.80	14
15		3.06					0.25		1.01					0.81	15
16		4.84					0.29		1.31					0.81	16
17		2.78					0.39		0.83					0.83	17
18		2.53					0.42		0.85					0.84	18
19		2.48					0.38		0.75					0.83	19
20		2.32					0.34		0.75					0.82	20
21		2.61					0.32		0.80					0.80	21
22		2.75					0.32		0.86					0.82	22
23		2.75					0.25		0.88					0.83	23
24		2.28					0.26		0.76					0.71	24
25		2.29					0.24		0.70					0.65	25
26		2.59					0.24		0.83					0.65	26
27		2.52					0.29		0.78					0.68	27
28		2.34					0.29		0.71					0.71	28
29		3.14					0.32		0.91					0.76	29
30		2.72					0.26		0.94					0.75	30
31															31

TABLE 3.1: DISINFECTION PROFILE (OCT 1984)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		1.91					0.31		0.63					0.75	1
2		2.76					0.33		0.84					0.75	2
3		1.52					0.25		0.48					0.76	3
4		2.20					0.29		0.70					0.76	4
5		2.33					0.35		0.74					0.78	5
6		2.42					0.26		0.71					0.76	6
7		2.24					0.27		0.83					0.75	7
8		2.97					0.27		0.72					0.76	8
9		2.24					0.35		0.75					0.76	9
10		2.36					0.29		0.67					0.76	10
11		2.15					0.31		0.72					0.76	11
12		2.39					0.30		0.74					0.75	12
13		3.53					0.29		0.93					0.75	13
14		2.34					0.31		0.86					0.75	14
15		2.15					0.31		0.67					0.76	15
16		2.25					0.21		0.63					0.76	16
17		1.88					0.34		0.59					0.75	17
18		1.97					0.25		0.59					0.75	18
19		2.21					0.31		0.66					0.75	19
20		1.84					0.27		0.65					0.74	20
21		2.08					0.24		0.62					0.74	21
22		2.25					0.32		0.80					0.75	22
23		2.05					0.24		0.60					0.75	23
24		1.85					0.33		0.56					0.73	24
25		1.81					0.38		0.55					0.75	25
26		1.64					0.31		0.52					0.77	26
27		1.88					0.26		0.68					0.75	27
28		2.46					0.32		0.71					0.77	28
29		1.88					0.28		0.52					0.76	29
30		1.71					0.32		0.62					0.78	30
31		1.82					0.37		0.60					0.78	31

TABLE 3.1: DISINFECTION PROFILE (NOV 1984)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		1.78					0.35		0.52					0.77	1
2		1.86					0.27		0.59					0.73	2
3		1.95					0.32		0.69					0.77	3
4		2.14					0.29		0.52					0.74	4
5		1.95					0.37		0.53					0.76	5
6		1.74					0.29		0.60					0.78	6
7		1.89					0.29		0.55					0.74	7
8		1.72					0.25		0.57					0.75	8
9		1.62					0.26		0.50					0.74	9
10		1.99					0.25		0.66					0.73	10
11		2.46					0.29		0.60					0.74	11
12		2.30					0.30		0.58					0.75	12
13		1.84					0.33		0.56					0.76	13
14		1.64					0.34		0.52					0.77	14
15		1.56					0.31		0.46					0.72	15
16		1.34					0.20		0.40					0.69	16
17		1.77					0.18		0.60					0.66	17
18		1.99					0.19		0.53					0.65	18
19		1.49					0.23		0.43					0.66	19
20		1.36					0.23		0.43					0.66	20
21		1.53					0.22		0.41					0.67	21
22		1.21					0.22		0.40					0.66	22
23		1.41					0.18		0.40					0.67	23
24		1.57					0.21		0.51					0.67	24
25		1.69					0.22		0.51					0.68	25
26		1.35					0.21		0.39					0.67	26
27		1.26					0.19		0.35					0.66	27
28		1.21					0.18		0.36					0.67	28
29		1.31					0.15		0.39					0.65	29
30		1.36					0.16		0.40					0.69	30
31															31

TABLE 3.1: DISINFECTION PROFILE (DEC 1984)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		1.23					0.15		0.44					0.65	1
2		2.56					0.16		0.52					0.66	2
3		1.49					0.19		0.41					0.67	3
4		1.25					0.17		0.38					0.66	4
5		1.49					0.14		0.40					0.64	5
6		1.27					0.15		0.38					0.65	6
7		1.43					0.15		0.42					0.67	7
8		1.41					0.15		0.47					0.65	8
9		2.14					0.18		0.47					0.66	9
10		1.07					0.16		0.30					0.67	10
11		1.33					0.15		0.37					0.66	11
12		1.31					0.17		0.37					0.67	12
13		1.23					0.16		0.35					0.66	13
14		1.24					0.17		0.36					0.67	14
15		1.73					0.16		0.46					0.67	15
16		1.38					0.15		0.38					0.66	16
17		1.34					0.14		0.41					0.66	17
18		1.62					0.17		0.47					0.65	18
19		1.19					0.16		0.38					0.66	19
20		1.47					0.16		0.40					0.66	20
21		1.18					0.18		0.33					0.67	21
22		0.88					0.17		0.32					0.66	22
23		1.43					0.15		0.45					0.65	23
24		1.21					0.17		0.29					0.65	24
25		1.15					0.14		0.48					0.66	25
26		1.53					0.14		0.39					0.64	26
27		0.98					0.16		0.36					0.66	27
28		1.39					0.19		0.31					0.67	28
29		1.06					0.16		0.40					0.66	29
30		1.44					0.14		0.36					0.66	30
31		0.88					0.16		0.32					0.66	31

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 3.1: DISINFECTION PROFILE (JAN 1985)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		1.30					0.17		0.36					0.68	1
2		1.22					0.14		0.33					0.66	2
3		1.12					0.15		0.37					0.66	3
4		1.20					0.17		0.33					0.66	4
5		1.14					0.16		0.39					0.66	5
6		1.25					0.15		0.42					0.64	6
7		1.24					0.16		0.34					0.64	7
8		1.19					0.17		0.37					0.66	8
9		1.19					0.18		0.34					0.67	9
10		1.09					0.17		0.34					0.67	10
11		1.13					0.17		0.31					0.66	11
12		1.13					0.19		0.38					0.66	12
13		1.20					0.18		0.37					0.67	13
14		1.10					0.18		0.31					0.64	14
15		0.97					0.18		0.30					0.67	15
16		1.14					0.17		0.31					0.67	16
17		1.05					0.19		0.34					0.68	17
18		0.91					0.19		0.26					0.66	18
19		0.96					0.18		0.34					0.66	19
20		0.96					0.17		0.35					0.64	20
21		0.87					0.18		0.27					0.66	21
22		1.05					0.17		0.31					0.66	22
23		1.01					0.17		0.31					0.67	23
24		0.92					0.19		0.28					0.66	24
25		0.95					0.18		0.26					0.67	25
26		0.96					0.18		0.33					0.66	26
27		0.87					0.18		0.32					0.66	27
28		0.93					0.19		0.30					0.67	28
29		1.04					0.18		0.32					0.67	29
30		0.99					0.17		0.29					0.67	30
31		1.00					0.18		0.29					0.66	31

TABLE 3.1: DISINFECTION PROFILE (FEB 1985)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		0.97					0.18		0.27					0.66	1
2		0.99					0.19		0.35					0.67	2
3		0.96					0.20		0.29					0.66	3
4		0.92					0.20		0.28					0.67	4
5		1.02					0.19		0.30					0.67	5
6		0.87					0.19		0.27					0.65	6
7		0.95					0.17		0.30					0.66	7
8		1.02					0.16		0.27					0.66	8
9		1.01					0.18		0.34					0.66	9
10		0.84					0.17		0.32					0.66	10
11		0.92					0.17		0.26					0.66	11
12		0.98					0.18		0.30					0.65	12
13		0.89					0.19		0.30					0.66	13
14		1.10					0.19		0.31					0.66	14
15		1.09					0.18		0.31					0.67	15
16		0.81					0.17		0.29					0.66	16
17		0.84					0.18		0.32					0.66	17
18		1.00					0.19		0.29					0.66	18
19		0.83					0.20		0.32					0.64	19
20		0.92					0.21		0.25					0.64	20
21		0.83					0.22		0.27					0.65	21
22		0.92					0.19		0.25					0.65	22
23		0.91					0.20		0.28					0.66	23
24		0.74					0.17		0.30					0.66	24
25		0.99					0.19		0.29					0.66	25
26		0.88					0.19		0.24					0.64	26
27		0.87					0.20		0.27					0.64	27
28		0.96					0.20		0.28					0.66	28
29															29
30															30
31															31

TABLE 3.1: DISINFECTION PROFILE (MAR 1985)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		0.85					0.19		0.28					0.64	1
2		0.88					0.17		0.32					0.64	2
3		0.96					0.17		0.37					0.66	3
4		1.04					0.17		0.33					0.69	4
5		1.14					0.20		0.34					0.67	5
6		0.97					0.24		0.27					0.67	6
7		0.92					0.20		0.30					0.65	7
8		0.90					0.18		0.26					0.65	8
9		0.91					0.18		0.33					0.64	9
10		0.82					0.16		0.32					0.65	10
11		0.90					0.18		0.28					0.65	11
12		1.08					0.17		0.30					0.67	12
13		1.13					0.14		0.36					0.67	13
14		1.21					0.16		0.37					0.67	14
15		1.17					0.16		0.34					0.67	15
16		0.97					0.16		0.35					0.66	16
17		1.45					0.17		0.40					0.67	17
18		1.14					0.16		0.34					0.67	18
19		1.21					0.15		0.34					0.68	19
20		1.21					0.16		0.37					0.66	20
21		1.14					0.15		0.37					0.67	21
22		1.25					0.17		0.37					0.67	22
23		1.06					0.18		0.38					0.67	23
24		1.11					0.15		0.38					0.68	24
25		1.20					0.19		0.33					0.67	25
26		1.18					0.18		0.36					0.67	26
27		1.15					0.17		0.39					0.66	27
28		1.14					0.17		0.34					0.66	28
29		1.37					0.20		0.44					0.65	29
30		1.61					0.20		0.46					0.67	30
31		1.65					0.21		0.37					0.66	31

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 3.1: DISINFECTION PROFILE (APR 1985)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		1.06					0.18		0.39					0.67	1
2		1.48					0.19		0.53					0.65	2
3		1.38					0.23		0.43					0.68	3
4		1.02					0.23		0.31					0.66	4
5		0.98					0.17		0.31					0.64	5
6		1.09					0.17		0.33					0.66	6
7		1.18					0.25		0.42					0.66	7
8		1.70					0.18		0.49					0.65	8
9		1.83					0.22		0.51					0.68	9
10		1.57					0.21		0.50					0.68	10
11		1.21					0.21		0.38					0.66	11
12		2.08					0.18		0.55					0.66	12
13		1.98					0.17		0.64					0.67	13
14		2.66					0.19		0.80					0.68	14
15		1.83					0.23		0.53					0.68	15
16		2.07					0.22		0.67					0.67	16
17		1.93					0.21		0.54					0.66	17
18		1.76					0.23		0.57					0.68	18
19		1.79					0.22		0.58					0.68	19
20		1.82					0.19		0.57					0.68	20
21		2.09					0.16		0.53					0.67	21
22		1.81					0.24		0.57					0.73	22
23		1.81					0.22		0.54					0.78	23
24		1.98					0.20		0.63					0.75	24
25		2.04					0.22		0.60					0.75	25
26		1.56					0.23		0.47					0.74	26
27		1.95					0.20		0.62					0.70	27
28		1.77					0.18		0.54					0.67	28
29		1.84					0.19		0.55					0.66	29
30		1.68					0.19		0.51					0.67	30
31															31

TABLE 3.1: DISINFECTION PROFILE (MAY 1985)

	PRE-CHLORINATION							POST-CHLORINATION							
DATE	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			DATE
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1	1.63						0.21		0.52					0.67	1
2	1.84						0.18		0.51					0.67	2
3	1.57						0.17		0.52					0.66	3
4	1.84						0.15		0.55					0.67	4
5	1.85						0.17		0.63					0.67	5
6	1.90						0.14		0.59					0.65	6
7	0.75						0.18		0.62					0.65	7
8	0.60						0.24		0.50					0.66	8
9	0.60						0.24		0.50					0.66	9
10	0.53						0.24		0.47					0.66	10
11	0.61						0.25		0.50					0.67	11
12	0.54						0.24		0.51					0.65	12
13	0.61						0.24		0.50					0.66	13
14	0.64						0.25		0.56					0.65	14
15	0.69						0.30		0.62					0.67	15
16	0.62						0.28		0.55					0.67	16
17	0.67						0.29		0.56					0.65	17
18	0.75						0.31		0.57					0.67	18
19	0.61						0.29		0.55					0.65	19
20	0.73						0.29		0.65					0.65	20
21	0.72						0.30		0.59					0.66	21
22	0.68						0.29		0.60					0.67	22
23	0.69						0.29		0.58					0.65	23
24	0.63						0.30		0.55					0.67	24
25	0.65						0.30		0.54					0.69	25
26	0.60						0.30		0.54					0.67	26
27	0.67						0.29		0.58					0.68	27
28	0.58						0.30		0.50					0.67	28
29	0.67						0.31		0.58					0.68	29
30	0.64						0.31		0.57					0.68	30
31	0.64						0.29		0.52					0.65	31

TABLE 3.1: DISINFECTION PROFILE (JUN 1985)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		0.66					0.29		0.56					0.65	1
2		0.67					0.30		0.56					0.66	2
3		0.62					0.30		0.53					0.65	3
4		0.56					0.30		0.50					0.69	4
5		0.65					0.31		0.52					0.68	5
6		0.58					0.30		0.47					0.68	6
7		0.53					0.29		0.46					0.68	7
8		0.58					0.29		0.49					0.67	8
9		0.63					0.28		0.53					0.64	9
10		0.54					0.30		0.48					0.66	10
11		0.59					0.27		0.54					0.66	11
12		0.63					0.29		0.56					0.66	12
13		0.65					0.29		0.53					0.66	13
14		0.64					0.29		0.51					0.65	14
15		0.65					0.28		0.65					0.67	15
16		0.59					0.28		0.48					0.66	16
17		0.62					0.30		0.51					0.67	17
18		0.63					0.29		0.53					0.66	18
19		0.60					0.28		0.48					0.68	19
20		0.57					0.31		0.50					0.67	20
21		0.55					0.29		0.47					0.68	21
22		0.61					0.28		0.56					0.65	22
23		0.59					0.30		0.50					0.68	23
24		0.59					0.29		0.51					0.67	24
25		0.60					0.28		0.49					0.67	25
26		0.62					0.27		0.55					0.68	26
27		0.58					0.31		0.51					0.68	27
28		0.60					0.28		0.52					0.66	28
29		0.66					0.29		0.53					0.64	29
30		0.58					0.29		0.53					0.67	30
31															31

TABLE 3.1: DISINFECTION PROFILE (JUL 1985)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		0.57					0.28		0.51					0.67	1
2		0.55					0.28		0.48					0.66	2
3		0.66					0.29		0.51					0.68	3
4		0.52					0.29		0.49					0.67	4
5		0.58					0.28		0.53					0.60	5
6		0.65					0.30		0.53					0.65	6
7		0.61					0.30		0.48					0.67	7
8		0.55					0.30		0.48					0.66	8
9		0.55					0.29		0.49					0.66	9
10		0.56					0.30		0.49					0.67	10
11		0.62					0.28		0.52					0.67	11
12		0.56					0.29		0.49					0.68	12
13		0.66					0.28		0.54					0.67	13
14		0.58					0.30		0.61					0.67	14
15		0.68					0.32		0.56					0.75	15
16		0.66					0.30		0.56					0.78	16
17		0.65					0.29		0.55					0.75	17
18		0.66					0.30		0.56					0.79	18
19		0.61					0.28		0.54					0.76	19
20		0.66					0.30		0.61					0.76	20
21		0.57					0.29		0.54					0.76	21
22		0.62					0.28		0.53					0.77	22
23		0.62					0.27		0.55					0.76	23
24		0.59					0.29		0.50					0.78	24
25		0.67					0.29		0.56					0.77	25
26		0.61					0.29		0.54					0.78	26
27		0.63					0.28		0.53					0.75	27
28		0.70					0.30		0.60					0.77	28
29		0.60					0.30		0.56					0.77	29
30		0.66					0.28		0.60					0.76	30
31		0.58					0.29		0.51					0.78	31

TABLE 3.1: DISINFECTION PROFILE (AUG 1985)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		0.57					0.30		0.52					0.77	1
2		0.66					0.26		0.55					0.78	2
3		0.65					0.28		0.58					0.78	3
4		0.64					0.29		0.59					0.76	4
5		0.62					0.30		0.57					0.77	5
6		0.69					0.30		0.60					0.78	6
7		0.62					0.29		0.55					0.77	7
8		0.62					0.27		0.55					0.77	8
9		0.56					0.27		0.51					0.73	9
10		0.67					0.28		0.56					0.75	10
11		0.69					0.27		0.59					0.73	11
12		0.59					0.27		0.54					0.77	12
13		0.64					0.27		0.56					0.79	13
14		0.66					0.28		0.60					0.78	14
15		0.63					0.27		0.56					0.78	15
16		0.68					0.30		0.59					0.77	16
17		0.69					0.29		0.61					0.78	17
18		0.67					0.28		0.59					0.76	18
19		0.65					0.29		0.56					0.80	19
20		0.61					0.27		0.54					0.76	20
21		0.65					0.29		0.57					0.77	21
22		0.65					0.28		0.57					0.79	22
23		0.65					0.28		0.56					0.78	23
24		0.71					0.28		0.63					0.78	24
25		0.66					0.29		0.57					0.77	25
26		0.66					0.28		0.57					0.77	26
27		0.62					0.29		0.55					0.76	27
28		0.63					0.27		0.54					0.77	28
29		0.66					0.26		0.56					0.76	29
30		0.62					0.27		0.54					0.78	30
31		0.65					0.26		0.55					0.77	31

TABLE 3.1: DISINFECTION PROFILE (SEP 1985)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		0.74					0.26		0.56					0.77	1
2		0.57					0.26		0.51					0.77	2
3		0.60					0.28		0.57					0.76	3
4		0.63					0.28		0.55					0.77	4
5		0.64					0.29		0.57					0.77	5
6		0.60					0.29		0.54					0.78	6
7		0.62					0.29		0.54					0.77	7
8		0.64					0.28		0.57					0.76	8
9		0.62					0.26		0.56					0.71	9
10		0.66					0.28		0.54					0.78	10
11		0.66					0.28		0.60					0.77	11
12		0.64					0.28		0.56					0.78	12
13		0.65					0.30		0.54					0.79	13
14		0.61					0.30		0.56					0.78	14
15		0.69					0.30		0.60					0.77	15
16		0.60					0.29		0.54					0.79	16
17		0.57					0.26		0.51					0.76	17
18		0.56					0.28		0.49					0.79	18
19		0.58					0.28		0.50					0.78	19
20		0.57					0.30		0.51					0.77	20
21		0.56					0.29		0.49					0.76	21
22		0.57					0.31		0.52					0.75	22
23		0.56					0.29		0.49					0.78	23
24		0.62					0.27		0.51					0.76	24
25		0.55					0.28		0.50					0.76	25
26		0.64					0.29		0.55					0.78	26
27		0.61					0.27		0.51					0.77	27
28		0.61					0.28		0.50					0.78	28
29		0.61					0.28		0.53					0.78	29
30		0.58					0.29		0.52					0.78	30
31															31

TABLE 3.1: DISINFECTION PROFILE (OCT 1985)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		0.61					0.27		0.51					0.77	1
2		0.57					0.28		0.49					0.78	2
3		0.60					0.30		0.49					0.79	3
4		0.55					0.26		0.51					0.77	4
5		0.65					0.30		0.56					0.77	5
6		0.53					0.28		0.50					0.76	6
7		0.66					0.31		0.51					0.78	7
8		0.61					0.29		0.51					0.79	8
9		0.58					0.28		0.47					0.77	9
10		0.54					0.30		0.47					0.76	10
11		0.51					0.26		0.46					0.76	11
12		0.63					0.28		0.62					0.75	12
13		0.58					0.29		0.48					0.78	13
14		0.66					0.28		0.49					0.78	14
15		0.59					0.27		0.51					0.76	15
16		0.60					0.27		0.49					0.76	16
17		0.62					0.28		0.55					0.77	17
18		0.65					0.29		0.52					0.77	18
19		0.47					0.28		0.50					0.78	19
20		0.70					0.29		0.55					0.76	20
21		0.64					0.28		0.48					0.75	21
22		0.62					0.29		0.52					0.76	22
23		0.57					0.28		0.50					0.75	23
24		0.58					0.26		0.56					0.77	24
25		0.65					0.23		0.55					0.76	25
26		0.68					0.28		0.63					0.78	26
27		0.73					0.29		0.61					0.79	27
28		0.71					0.30		0.52					0.77	28
29		0.66					0.28		0.54					0.78	29
30		0.61					0.29		0.61					0.78	30
31		0.66					0.27		0.54					0.78	31

TABLE 3.1: DISINFECTION PROFILE (NOV 1985)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		0.62					0.29		0.53					0.77	1
2		0.61					0.26		0.64					0.76	2
3		0.84					0.27		0.59					0.76	3
4		0.61					0.28		0.53					0.76	4
5		0.65					0.29		0.54					0.76	5
6		0.70					0.27		0.58					0.75	6
7		0.70					0.26		0.53					0.75	7
8		0.66					0.27		0.60					0.78	8
9		0.87					0.28		0.74					0.78	9
10		0.72					0.28		0.59					0.77	10
11		0.74					0.30		0.58					0.79	11
12		0.58					0.27		0.47					0.78	12
13		0.59					0.27		0.47					0.74	13
14		0.62					0.29		0.56					0.79	14
15		0.64					0.28		0.54					0.78	15
16		0.59					0.28		0.56					0.78	16
17		0.63					0.28		0.58					0.78	17
18		0.64					0.28		0.51					0.78	18
19		0.63					0.28		0.56					0.77	19
20		0.68					0.28		0.50					0.76	20
21		0.59					0.27		0.51					0.77	21
22		0.62					0.28		0.50					0.78	22
23		0.63					0.28		0.61					0.78	23
24		0.55					0.29		0.55					0.78	24
25		0.60					0.28		0.46					0.77	25
26		0.64					0.27		0.52					0.78	26
27		0.49					0.28		0.45					0.78	27
28		0.71					0.29		0.47					0.74	28
29		0.52					0.30		0.53					0.78	29
30		0.59					0.29		0.47					0.77	30
31															31

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 3.1: DISINFECTION PROFILE (DEC 1985)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		0.79					0.27		0.49					0.75	1
2		0.70					0.28		0.57					0.77	2
3		0.65					0.30		0.53					0.77	3
4		0.58					0.27		0.44					0.76	4
5		0.60					0.28		0.59					0.75	5
6		0.65					0.27		0.45					0.77	6
7		0.57					0.28		0.52					0.77	7
8		0.77					0.28		0.58					0.75	8
9		0.60					0.29		0.50					0.78	9
10		0.66					0.29		0.55					0.77	10
11		0.61					0.30		0.53					0.77	11
12		0.61					0.29		0.47					0.76	12
13		0.61					0.27		0.52					0.74	13
14		0.63					0.28		0.56					0.74	14
15		0.56					0.27		0.54					0.76	15
16		0.69					0.30		0.50					0.73	16
17		0.62					0.30		0.59					0.74	17
18		0.56					0.29		0.55					0.72	18
19		0.62					0.26		0.59					0.74	19
20		0.68					0.27		0.66					0.76	20
21		0.68					0.26		0.62					0.77	21
22		0.57					0.28		0.57					0.76	22
23		0.67					0.28		0.63					0.78	23
24		0.69					0.29		0.60					0.76	24
25		0.64					0.28		0.63					0.78	25
26		0.57					0.28		0.56					0.76	26
27		0.70					0.29		0.62					0.78	27
28		0.58					0.28		0.51					0.78	28
29		0.64					0.27		0.60					0.78	29
30		0.57					0.23		0.53					0.77	30
31		0.63					0.22		0.56					0.77	31

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 3.1: DISINFECTION PROFILE (JAN 1986)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		0.49					0.21		0.49					0.74	1
2		0.62					0.22		0.50					0.75	2
3		0.62					0.23		0.47					0.75	3
4		0.48					0.22		0.48					0.73	4
5		0.59					0.23		0.64					0.75	5
6		0.60					0.24		0.49					0.76	6
7		0.59					0.24		0.49					0.75	7
8		0.67					0.23		0.57					0.76	8
9		0.66					0.22		0.53					0.77	9
10		0.72					0.21		0.47					0.76	10
11		0.55					0.23		0.58					0.77	11
12		0.48					0.23		0.50					0.76	12
13		0.70					0.23		0.50					0.74	13
14		0.56					0.24		0.50					0.74	14
15		0.55					0.23		0.48					0.75	15
16		0.60					0.24		0.53					0.78	16
17		0.59					0.22		0.46					0.76	17
18		0.58					0.22		0.54					0.78	18
19		0.41					0.21		0.45					0.76	19
20		0.60					0.24		0.56					0.74	20
21		0.67					0.22		0.53					0.75	21
22		0.57					0.22		0.51					0.74	22
23		0.62					0.23		0.52					0.76	23
24		0.64					0.23		0.48					0.74	24
25		0.56					0.22		0.59					0.76	25
26		0.46					0.23		0.55					0.75	26
27		0.59					0.23		0.50					0.75	27
28		0.44					0.24		0.39					0.78	28
29		0.82					0.23		0.66					0.74	29
30		0.53					0.23		0.51					0.78	30
31		0.60					0.23		0.50					0.77	31

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 3.1: DISINFECTION PROFILE (FEB 1986)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dos.	Dem.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1	0.51						0.22		0.51					0.77	1
2	0.52						0.22		0.58					0.77	2
3	0.65						0.22		0.54					0.76	3
4	0.49						0.22		0.43					0.78	4
5	0.56						0.22		0.49					0.76	5
6	0.62						0.22		0.54					0.77	6
7	0.64						0.24		0.50					0.79	7
8	0.51						0.21		0.50					0.79	8
9	0.46						0.21		0.51					0.77	9
10	0.61						0.21		0.53					0.77	10
11	0.60						0.22		0.50					0.79	11
12	0.61						0.23		0.51					0.77	12
13	0.48						0.22		0.50					0.76	13
14	0.71						0.22		0.49					0.77	14
15	0.61						0.23		0.57					0.80	15
16	0.49						0.22		0.52					0.76	16
17	0.60						0.22		0.54					0.76	17
18	0.57						0.22		0.49					0.77	18
19	0.52						0.22		0.46					0.76	19
20	0.61						0.22		0.53					0.77	20
21	0.61						0.22		0.43					0.76	21
22	0.61						0.23		0.57					0.75	22
23	0.55						0.23		0.58					0.78	23
24	0.58						0.24		0.49					0.76	24
25	0.60						0.24		0.52					0.76	25
26	0.65						0.22		0.51					0.76	26
27	0.54						0.21		0.51					0.77	27
28	0.80						0.21		0.54					0.78	28
29															29
30															30
31															31

TABLE 3.1: DISINFECTION PROFILE (MAR 1986)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		0.57					0.23		0.52					0.78	1
2		0.50					0.22		0.48					0.76	2
3		0.59					0.23		0.49					0.78	3
4		0.56					0.23		0.50					0.76	4
5		0.62					0.23		0.49					0.78	5
6		0.59					0.22		0.53					0.77	6
7		0.68					0.22		0.48					0.76	7
8		0.55					0.22		0.48					0.75	8
9		0.55					0.22		0.56					0.75	9
10		0.63					0.22		0.50					0.75	10
11		0.57					0.24		0.46					0.77	11
12		0.57					0.23		0.52					0.75	12
13		0.61					0.23		0.48					0.78	13
14		0.60					0.23		0.49					0.77	14
15		0.61					0.22		0.54					0.76	15
16		0.55					0.24		0.55					0.77	16
17		0.54					0.22		0.47					0.78	17
18		0.62					0.21		0.50					0.76	18
19		0.56					0.21		0.49					0.76	19
20		0.64					0.22		0.55					0.75	20
21		0.61					0.25		0.46					0.77	21
22		0.57					0.25		0.53					0.77	22
23		0.61					0.21		0.57					0.76	23
24		0.62					0.23		0.48					0.77	24
25		0.55					0.22		0.51					0.76	25
26		0.62					0.21		0.51					0.76	26
27		0.63					0.22		0.56					0.77	27
28		0.55					0.23		0.41					0.77	28
29		0.67					0.23		0.56					0.78	29
30		0.54					0.23		0.50					0.76	30
31		0.56					0.24		0.46					0.77	31

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 3.1: DISINFECTION PROFILE (APR 1986)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		0.59					0.24		0.49					0.76	1
2		0.54					0.24		0.47					0.77	2
3		0.55					0.76		0.49					0.81	3
4		0.52					0.23		0.48					0.78	4
5		0.57					0.27		0.52					0.76	5
6		0.61					0.26		0.57					0.76	6
7		0.54					0.27		0.46					0.77	7
8		0.62					0.26		0.53					0.76	8
9		0.59					0.22		0.51					0.76	9
10		0.66					0.25		0.54					0.75	10
11		0.66					0.23		0.54					0.75	11
12		0.71					0.26		0.55					0.78	12
13		0.60					0.27		0.56					0.77	13
14		0.65					0.27		0.49					0.79	14
15		0.64					0.26		0.61					0.80	15
16		0.51					0.26		0.47					0.74	16
17		0.63					0.28		0.56					0.76	17
18		0.58					0.28		0.47					0.76	18
19		0.60					0.25		0.54					0.76	19
20		0.65					0.25		0.59					0.76	20
21		0.62					0.28		0.53					0.75	21
22		0.68					0.28		0.55					0.77	22
23		0.67					0.28		0.54					0.79	23
24		0.60					0.26		0.57					0.75	24
25		0.57					0.26		0.46					0.76	25
26		0.62					0.23		0.57					0.75	26
27		0.58					0.22		0.39					0.75	27
28		0.57					0.24		0.48					0.75	28
29		0.56					0.24		0.55					0.76	29
30		0.58					0.26		0.53					0.76	30
31															31

TABLE 3.1: DISINFECTION PROFILE (MAY 1986)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		0.66					0.25		0.53					0.76	1
2		0.61					0.24		0.58					0.76	2
3		0.57					0.24		0.52					0.74	3
4		0.76					0.27		0.61					0.73	4
5		0.60					0.27		0.48					0.77	5
6		0.58					0.23		0.50					0.73	6
7		0.55					0.24		0.51					0.73	7
8		0.62					0.24		0.51					0.75	8
9		0.60					0.22		0.53					0.74	9
10		0.59					0.24		0.47					0.74	10
11		0.63					0.24		0.62					0.75	11
12		0.58					0.24		0.50					0.77	12
13		0.61					0.25		0.56					0.74	13
14		0.55					0.25		0.49					0.75	14
15		0.57					0.23		0.50					0.76	15
16		0.59					0.23		0.54					0.75	16
17		0.66					0.24		0.57					0.74	17
18		0.62					0.23		0.59					0.77	18
19		0.80					0.24		0.70					0.77	19
20		0.63					0.25		0.50					0.77	20
21		0.65					0.23		0.59					0.75	21
22		0.66					0.23		0.50					0.75	22
23		0.56					0.23		0.54					0.78	23
24		0.66					0.24		0.59					0.78	24
25		0.69					0.23		0.58					0.78	25
26		0.66					0.22		0.55					0.74	26
27		0.55					0.24		0.49					0.76	27
28		0.62					0.25		0.54					0.78	28
29		0.57					0.23		0.50					0.76	29
30		0.67					0.25		0.53					0.77	30
31		0.56					0.25		0.52					0.76	31

TABLE 3.1: DISINFECTION PROFILE (JUN 1986)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		0.63					0.24		0.58					0.75	1
2		0.68					0.23		0.58					0.76	2
3		0.60					0.24		0.50					0.77	3
4		0.63					0.23		0.52					0.74	4
5		0.55					0.24		0.53					0.76	5
6		0.70					0.25		0.55					0.77	6
7		0.59					0.24		0.52					0.78	7
8		0.50					0.23		0.48					0.75	8
9		0.64					0.24		0.52					0.76	9
10		0.64					0.25		0.57					0.78	10
11		0.58					0.23		0.46					0.76	11
12		0.56					0.24		0.52					0.76	12
13		0.63					0.22		0.54					0.76	13
14		0.71					0.25		0.68					0.75	14
15		0.57					0.24		0.56					0.75	15
16		0.68					0.24		0.54					0.77	16
17		0.67					0.25		0.57					0.76	17
18		0.69					0.25		0.58					0.77	18
19		0.59					0.22		0.51					0.78	19
20		0.64					0.21		0.53					0.75	20
21		0.64					0.24		0.57					0.74	21
22		0.69					0.23		0.56					0.76	22
23		0.62					0.20		0.53					0.74	23
24		0.64					0.22		0.55					0.74	24
25		0.70					0.24		0.56					0.76	25
26		0.63					0.23		0.53					0.78	26
27		0.56					0.24		0.52					0.77	27
28		0.69					0.26		0.52					0.77	28
29		0.57					0.25		0.55					0.76	29
30		0.55					0.27		0.49					0.74	30
31															31

TABLE 3.1: DISINFECTION PROFILE (JUL 1986)

DATE	PRE-CHLORINATION							POST-CHLORINATION							DATE
	Cl2		NH3	SO2	RESIDUAL Cl2			Cl2		NH3	SO2	RESIDUAL Cl2			
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total	
1		0.57					0.24		0.47					0.74	1
2		0.50					0.22		0.41					0.74	2
3		0.59					0.24		0.56					0.76	3
4		0.59					0.23		0.47					0.78	4
5		0.58					0.24		0.50					0.77	5
6		0.57					0.24		0.50					0.77	6
7		0.58					0.23		0.50					0.75	7
8		0.51					0.22		0.49					0.76	8
9		0.57					0.22		0.52					0.75	9
10		0.56					0.24		0.48					0.75	10
11		0.61					0.23		0.51					0.78	11
12		0.50					0.25		0.55					0.75	12
13		0.67					0.27		0.38					0.76	13
14		0.61					0.22		0.54					0.77	14
15		0.62					0.22		0.52					0.78	15
16		0.62					0.24		0.55					0.79	16
17		0.58					0.22		0.48					0.77	17
18		0.61					0.24		0.55					0.74	18
19		0.57					0.23		0.49					0.76	19
20		0.61					0.24		0.52					0.76	20
21		0.64					0.22		0.54					0.78	21
22		0.64					0.23		0.55					0.78	22
23		0.63					0.24		0.55					0.80	23
24		0.59					0.23		0.54					0.79	24
25		0.59					0.22		0.55					0.76	25
26		0.60					0.21		0.56					0.78	26
27		0.72					0.23		0.66					0.75	27
28		0.58					0.25		0.53					0.79	28
29		0.63					0.23		0.54					0.77	29
30		0.62					0.23		0.51					0.75	30
31		0.57					0.23		0.52					0.75	31

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 4.0: T&O CONTROL ALKALINITY ADJ. & FLUORIDATION SUMMARY

	UNITS mg/L	1986			1985			1984			1983		
		MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JAN	PAC	2.00	2.00	2.00									
	KMNo4												
	Lime												
	Soda Ash												
	F Dos.												
	F Res.												
FEB	PAC	2.00	2.00	2.00									
	KMNo4												
	Lime												
	Soda Ash												
	F Dos.												
	F Res.												
MAR	PAC	2.00	2.00	2.00									
	KMNo4												
	Lime												
	Soda Ash												
	F Dos.												
	F Res.												
APR	PAC	2.00	2.00	2.00									
	KMNo4												
	Lime												
	Soda Ash												
	F Dos.												
	F Res.												

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 4.0: T&O CONTROL ALKALINITY ADJ. &
FLUORIDATION SUMMARY

	UNITS mg/L	1986			1985			1984			1983		
		MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
MAY	PAC	2.00	0.50	1.95	3.00	1.00	1.71	1.00	0.75	0.91			
	KMNo4												
	Lime												
	Soda Ash												
	F Dos.												
	F Res.												
JUN	PAC	2.00	2.00	2.00	1.50	1.00	1.02	1.25	0.75	0.81			
	KMNo4												
	Lime												
	Soda Ash												
	F Dos.												
	F Res.												
JUL	PAC	2.00	2.00	2.00	1.50	1.00	1.02	2.00	1.00	1.64			
	KMNo4												
	Lime												
	Soda Ash												
	F Dos.												
	F Res.												
AUG	PAC				1.50	1.50	1.50	1.25	1.25	1.25			
	KMNo4												
	Lime												
	Soda Ash												
	F Dos.												
	F Res.												

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 4.0: T&O CONTROL ALKALINITY ADJ. &
FLUORIDATION SUMMARY

	UNITS mg/L	1986			1985			1984			1983		
		MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
SEP	PAC				1.50	1.00	1.28	1.25	1.00	1.16			
	KMNo4												
	Lime												
	Soda Ash												
	F Dos.												
	F Res.												
OCT	PAC				1.00	0.75	0.80	1.00	1.00	1.00			
	KMNo4												
	Lime												
	Soda Ash												
	F Dos.												
	F Res.												
NOV	PAC				5.00	0.75	4.03						
	KMNo4												
	Lime												
	Soda Ash												
	F Dos.												
	F Res.												
DEC	PAC				5.00	2.00	2.42						
	KMNo4												
	Lime												
	Soda Ash												
	F Dos.												
	F Res.												

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & (MAY 1984)
FLUORIDATION PROFILE

DATE	PAC mg/L	KMnO4	LIME	SODA ASH	NaHCO3	FLUORIDE Dosage	FLUORIDE Residual
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16	0.75						
17	0.75						
18	0.75						
19	0.75						
20	0.75						
21	0.75						
22	1.00						
23	1.00						
24	1.00						
25	1.00						
26	1.00						
27	1.00						
28	1.00						
29	1.00						
30	1.00						
31	1.00						

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & FLUORIDATION PROFILE (JUN 1984)

DATE	PAC mg/L	KMnO4	LIME	SODA ASH	NaHCO3	FLUORIDE Dosage	FLUORIDE Residual
1	1.00						
2	1.00						
3	1.00						
4	0.75						
5	0.75						
6	0.75						
7	0.75						
8	0.75						
9	0.75						
10	0.75						
11	0.75						
12	0.75						
13	0.75						
14	0.75						
15	0.75						
16	0.75						
17	0.75						
18	0.75						
19	0.75						
20	0.75						
21	0.75						
22	0.75						
23	0.75						
24	0.75						
25	0.75						
26	0.75						
27	0.75						
28	0.75						
29	1.25						
30	1.25						
31							

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & (JUL 1984)
FLUORIDATION PROFILE

DATE	PAC mg/L	KMnO4	LIME	SODA ASH	NaHCO3	FLUORIDE Dosage	FLUORIDE Residual
1	1.25						
2	1.50						
3	1.50						
4	1.50						
5	1.50						
6	1.50						
7	1.00						
8	1.00						
9	1.00						
10	1.00						
11	1.25						
12	2.00						
13	2.00						
14	2.00						
15	2.00						
16	2.00						
17	2.00						
18	2.00						
19	2.00						
20	2.00						
21	1.75						
22	1.75						
23	1.75						
24	1.75						
25	1.75						
26	1.75						
27	1.75						
28	1.75						
29	1.75						
30	1.75						
31	1.25						

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & FLUORIDATION PROFILE (AUG 1984)

DATE	PAC mg/L	KMnO4	LIME	SODA ASH	NaHCO3	FLUORIDE Dosage	FLUORIDE Residual
1	1.25						
2	1.25						
3	1.25						
4	1.25						
5	1.25						
6	1.25						
7	1.25						
8	1.25						
9	1.25						
10	1.25						
11	1.25						
12	1.25						
13	1.25						
14	1.25						
15	1.25						
16	1.25						
17	1.25						
18	1.25						
19	1.25						
20	1.25						
21	1.25						
22	1.25						
23	1.25						
24	1.25						
25	1.25						
26	1.25						
27	1.25						
28	1.25						
29	1.25						
30	1.25						
31	1.25						

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & (SEP 1984)
FLUORIDATION PROFILE

DATE	PAC mg/L	KMnO4	LIME	SODA ASH	NaHCO3	FLUORIDE Dosage	FLUORIDE Residual
1	1.25						
2	1.25						
3	1.25						
4	1.25						
5	1.00						
6	1.00						
7	1.00						
8	1.00						
9	1.00						
10	1.00						
11	1.00						
12	1.00						
13	1.25						
14	1.25						
15	1.25						
16	1.25						
17	1.25						
18	1.25						
19	1.25						
20	1.25						
21	1.25						
22	1.25						
23	1.25						
24	1.25						
25	1.25						
26	1.25						
27	1.25						
28	1.00						
29	1.00						
30	1.00						
31							

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & FLUORIDATION PROFILE (OCT 1984)

DATE	PAC mg/L	KMnO4	LIME	SODA ASH	NaHCO3	FLUORIDE Dosage	FLUORIDE Residual
1	1.00						
2	1.00						
3	1.00						
4	1.00						
5	1.00						
6	1.00						
7	1.00						
8	1.00						
9	1.00						
10	1.00						
11	1.00						
12	1.00						
13	1.00						
14	1.00						
15	1.00						
16	1.00						
17	1.00						
18	1.00						
19	1.00						
20	1.00						
21	1.00						
22	1.00						
23	1.00						
24	1.00						
25	1.00						
26	1.00						
27	1.00						
28	1.00						
29	1.00						
30							
31							

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & (MAY 1985)
FLUORIDATION PROFILE

DATE	PAC mg/L	KMnO4	LIME	SODA ASH	NaHCO3	FLUORIDE Dosage	FLUORIDE Residual
1	1						
2	1						
3	2						
4	2						
5	2						
6	2						
7	3						
8	3						
9	3						
10	2						
11	2						
12	2						
13	2						
14	2						
15	2						
16	2						
17	2						
18	2						
19	2						
20	2						
21	2						
22	1						
23	1						
24	1						
25	1						
26	1						
27	1						
28	1						
29	1						
30	1						
31	1						

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & FLUORIDATION PROFILE (JUN 1985)

DATE	PAC mg/L	KMnO4	LIME	SODA ASH	NaHCO3	FLUORIDE Dosage	FLUORIDE Residual
1	1.5						
2	1						
3	1						
4	1						
5	1						
6	1						
7	1						
8	1						
9	1						
10	1						
11	1						
12	1						
13	1						
14	1						
15	1						
16	1						
17	1						
18	1						
19	1						
20	1						
21	1						
22	1						
23	1						
24	1						
25	1						
26	1						
27	1						
28	1						
29	1						
30	1						
31							

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & (JUL 1985)
FLUORIDATION PROFILE

DATE	PAC mg/L	KMnO4	LIME	SODA ASH	NaHCO3	FLUORIDE Dosage	FLUORIDE Residual
1	1.00						
2	1.00						
3	1.00						
4	1.00						
5	1.00						
6	1.00						
7	1.00						
8	1.00						
9	1.00						
10	1.00						
11	1.00						
12	1.00						
13	1.00						
14	1.00						
15	1.00						
16	1.00						
17	1.00						
18	1.00						
19	1.00						
20	1.00						
21	1.00						
22	1.00						
23	1.00						
24	1.00						
25	1.00						
26	1.00						
27	1.00						
28	1.00						
29	1.00						
30	1.00						
31	1.50						

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & FLUORIDATION PROFILE (AUG 1985)

DATE	PAC mg/L	KMnO4	LIME	SODA ASH	NaHCO3	FLUORIDE Dosage	FLUORIDE Residual
1	1.50						
2	1.50						
3	1.50						
4	1.50						
5	1.50						
6	1.50						
7	1.50						
8	1.50						
9	1.50						
10	1.50						
11	1.50						
12	1.50						
13	1.50						
14	1.50						
15	1.50						
16	1.50						
17	1.50						
18	1.50						
19	1.50						
20	1.50						
21	1.50						
22	1.50						
23	1.50						
24	1.50						
25	1.50						
26	1.50						
27	1.50						
28	1.50						
29	1.50						
30	1.50						
31	1.50						

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & FLUORIDATION PROFILE (SEP 1985)

DATE	PAC mg/L	KMnO4	LIME	SODA ASH	NaHCO3	FLUORIDE Dosage	FLUORIDE Residual
1	1.50						
2	1.50						
3	1.50						
4	1.50						
5	1.50						
6	1.50						
7	1.50						
8	1.50						
9	1.50						
10	1.50						
11	1.50						
12	1.50						
13	1.50						
14	1.50						
15	1.50						
16	1.50						
17	1.50						
18	1.00						
19	1.00						
20	1.00						
21	1.00						
22	1.00						
23	1.00						
24	1.00						
25	1.00						
26	1.00						
27	1.00						
28	1.00						
29	1.00						
30	1.00						
31							

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & (OCT 1985)
FLUORIDATION PROFILE

DATE	PAC mg/L	KMnO4	LIME	SODA ASH	NaHCO3	FLUORIDE Dosage	FLUORIDE Residual
1	1.00						
2	1.00						
3	1.00						
4	1.00						
5	1.00						
6	1.00						
7	0.75						
8	0.75						
9	0.75						
10	0.75						
11	0.75						
12	0.75						
13	0.75						
14	0.75						
15	0.75						
16	0.75						
17	0.75						
18	0.75						
19	0.75						
20	0.75						
21	0.75						
22	0.75						
23	0.75						
24	0.75						
25	0.75						
26	0.75						
27	0.75						
28	0.75						
29	0.75						
30	0.75						
31	0.75						

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & (NOV 1985)
FLUORIDATION PROFILE

DATE	PAC mg/L	KMnO4	LIME	SODA ASH	NaHCO3	FLUORIDE Dosage	FLUORIDE Residual
1	0.75						
2	0.75						
3	0.75						
4	0.75						
5	0.75						
6	3.00						
7	5.00						
8	5.00						
9	3.00						
10	3.00						
11	3.00						
12	5.00						
13	5.00						
14	5.00						
15	5.00						
16	5.00						
17	5.00						
18	5.00						
19	5.00						
20	5.00						
21	5.00						
22	5.00						
23	5.00						
24	5.00						
25	5.00						
26	5.00						
27	5.00						
28	5.00						
29	5.00						
30	5.00						
31							

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & FLUORIDATION PROFILE (DEC 1985)

DATE	PAC mg/L	KMnO4	LIME	SODA ASH	NaHCO3	FLUORIDE Dosage	FLUORIDE Residual
1	3.00						
2	5.00						
3	5.00						
4	5.00						
5	5.00						
6	2.00						
7	2.00						
8	2.00						
9	2.00						
10	2.00						
11	2.00						
12	2.00						
13	2.00						
14	2.00						
15	2.00						
16	2.00						
17	2.00						
18	2.00						
19	2.00						
20	2.00						
21	2.00						
22	2.00						
23	2.00						
24	2.00						
25	2.00						
26	2.00						
27	2.00						
28	2.00						
29	2.00						
30	2.00						
31	2.00						

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & FLUORIDATION PROFILE (JAN 1986)

DATE	PAC mg/L	KMnO4	LIME	SODA ASH	NaHCO3	FLUORIDE Dosage	FLUORIDE Residual
1	2.00						
2	2.00						
3	2.00						
4	2.00						
5	2.00						
6	2.00						
7	2.00						
8	2.00						
9	2.00						
10	2.00						
11	2.00						
12	2.00						
13	2.00						
14	2.00						
15	2.00						
16	2.00						
17	2.00						
18	2.00						
19	2.00						
20	2.00						
21	2.00						
22	2.00						
23	2.00						
24	2.00						
25	2.00						
26	2.00						
27	2.00						
28	2.00						
29	2.00						
30	2.00						
31	2.00						

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & FLUORIDATION PROFILE (FEB 1986)

DATE	PAC mg/L	KMnO4	LIME	SODA ASH	NaHCO3	FLUORIDE Dosage	FLUORIDE Residual
1	2.00						
2	2.00						
3	2.00						
4	2.00						
5	2.00						
6	2.00						
7	2.00						
8	2.00						
9	2.00						
10	2.00						
11	2.00						
12	2.00						
13	2.00						
14	2.00						
15	2.00						
16	2.00						
17	2.00						
18	2.00						
19	2.00						
20	2.00						
21	2.00						
22	2.00						
23	2.00						
24	2.00						
25	2.00						
26	2.00						
27	2.00						
28	2.00						
29							
30							
31							

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & (MAR 1986)
FLUORIDATION PROFILE

DATE	PAC mg/L	KMnO4	LIME	SODA ASH	NaHCO3	FLUORIDE Dosage	FLUORIDE Residual
1	2.00						
2	2.00						
3	2.00						
4	2.00						
5	2.00						
6	2.00						
7	2.00						
8	2.00						
9	2.00						
10	2.00						
11	2.00						
12	2.00						
13	2.00						
14	2.00						
15	2.00						
16	2.00						
17	2.00						
18	2.00						
19	2.00						
20	2.00						
21	2.00						
22	2.00						
23	2.00						
24	2.00						
25	2.00						
26	2.00						
27	2.00						
28	2.00						
29	2.00						
30	2.00						
31	2.00						

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & FLUORIDATION PROFILE (APR 1986)

DATE	PAC mg/L	KMnO4	LIME	SODA ASH	NaHCO3	FLUORIDE Dosage	FLUORIDE Residual
1	2.00						
2	2.00						
3	2.00						
4	2.00						
5	2.00						
6	2.00						
7	2.00						
8	2.00						
9	2.00						
10	2.00						
11	2.00						
12	2.00						
13	2.00						
14	2.00						
15	2.00						
16	2.00						
17	2.00						
18	2.00						
19	2.00						
20	2.00						
21	2.00						
22	2.00						
23	2.00						
24	2.00						
25	2.00						
26	2.00						
27	2.00						
28	2.00						
29	2.00						
30	2.00						
31							

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & FLUORIDATION PROFILE (MAY 1986)

DATE	PAC mg/L	KMnO4	LIME	SODA ASH	NaHCO3	FLUORIDE Dosage	FLUORIDE Residual
1	2.00						
2	2.00						
3	2.00						
4	2.00						
5	2.00						
6	2.00						
7	2.00						
8	2.00						
9	2.00						
10	2.00						
11	2.00						
12	2.00						
13	2.00						
14	2.00						
15	2.00						
16	2.00						
17	2.00						
18	2.00						
19	2.00						
20	2.00						
21	2.00						
22	2.00						
23	2.00						
24	2.00						
25	2.00						
26	0.50						
27	2.00						
28	2.00						
29	2.00						
30	2.00						
31	2.00						

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & FLUORIDATION PROFILE (JUN 1986)

DATE	PAC mg/L	KMnO4	LIME	SODA ASH	NaHCO3	FLUORIDE Dosage	FLUORIDE Residual
1	2.00						
2	2.00						
3	2.00						
4	2.00						
5	2.00						
6	2.00						
7	2.00						
8	2.00						
9	2.00						
10	2.00						
11	2.00						
12	2.00						
13	2.00						
14	2.00						
15	2.00						
16	2.00						
17	2.00						
18	2.00						
19	2.00						
20	2.00						
21	2.00						
22	2.00						
23	2.00						
24	2.00						
25	2.00						
26	2.00						
27	2.00						
28	2.00						
29	2.00						
30	2.00						
31							

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & (JUL 1986)
FLUORIDATION PROFILE

DATE	PAC mg/L	KMnO4	LIME	SODA ASH	NaHCO3	FLUORIDE Dosage	FLUORIDE Residual
1	2.00						
2	2.00						
3	2.00						
4	2.00						
5	2.00						
6	2.00						
7	2.00						
8	2.00						
9	2.00						
10	2.00						
11	2.00						
12	2.00						
13	2.00						
14	2.00						
15	2.00						
16	2.00						
17	2.00						
18	2.00						
19	2.00						
20	2.00						
21	2.00						
22	2.00						
23	2.00						
24	2.00						
25	2.00						
26	2.00						
27	2.00						
28	2.00						
29	2.00						
30	2.00						
31	2.00						

TABLE 5.0

WPOS

PLANT UNION WATER SYSTEM WATER QUALITY - 4-YEAR SUMMARY (1983 - 1986)

GENERAL CHEMISTRY		1986			1985			1984			1983			DWSP DETECTION LIMIT*	DRINKING WATER OBJ/ GUIDELINE[1]
		MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE		
GENERAL CHEMISTRY															
ALKALINITY	R	91.5	86.8	88.8									93	0.2	
mg/L	T												82	mg/L	
AMMONIUM TOTAL	R						.025	.090	.006	.033			.024	0.05	
mg/L	T													mg/L	
CALCIUM	R	32.5	29	30.6										0.1	
mg/L	T													mg/L	
CHLORIDE	R	19	10	13.1			15	15	12	15.5			13.1	0.2	250
mg/L	T												13.5	mg/L	mg/L
COLOUR TCU	R						8.5	15	1	6.8				0.5	5
	T						1.27	4	1	1.6				TCU	TCU
CONDUCTIVITY	R	286	248	263			264	292	253	266			253	0.01	
umho/cm	T												258	UMHO/CM	
FIELD CHLORINE (COMBINED)	R													0.1	
	T													mg/L	
FIELD CHLORINE (FREE)	R													0.1	
	T													mg/L	
FIELD CHLORINE (TOTAL)	R													0.1	
	T													mg/L	
FIELD PH	R												7.9	0.2	
	T												7.5		

TABLE 5.0

WPOS

PLANT UNION WATER SYSTEM WATER QUALITY - 4-YEAR SUMMARY (1983 - 1986)

GENERAL CHEMISTRY (Cont'd)		1986			1985			1984			1983			DWSP DETECTION LIMIT*	DRINKING WATER OBJ/ GUIDELINE[1]
		MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE		
FIELD TEMPERATURE	R														
	T														
FIELD TURBIDITY	R														1 FTU
	T														
FLUORIDE	R													0.01	2.4
mg/L	T													mg/L	mg/L
HARDNESS	R	113	98	107									114	0.5	
mg/L	T												115	mg/L	
MAGNESIUM	R	8.6	6.4	7.3										0.05	
mg/L	T													mg/L	c
NITRATE	R	.7	<.1	.3			.458	.710	.175	.408			.370	0.05	10 mg/L
mg/L	T													mg/L	as N
NITRITE	R	.07	<.01	<.01			.009	.019	.001	.008			.008	0.005	1 mg/L
mg/L	T													mg/L	as N
NITROGEN TOTAL KJELDAHL	R	.66	.21	.30			.334	.380	.240	.305			0.37	0.1	0.15
mg/L	T													mg/L	mg/L *
PH	R														
	T														
PHOSPHORUS FILTERED REACTIVE	R													0.01	
mg/L	T													mg/L	

TABLE 5.0

WPOS

PLANT UNION WATER SYSTEM WATER QUALITY - 4-YEAR SUMMARY (1983 - 1986)

GENERAL CHEMISTRY (Cont'd)		1986			1985			1984			1983			DWSP DETECTION LIMIT*	DRINKING WATER OBJ/ GUIDELINE[1]
		MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE		
PHOSPHORUS TOTAL	R	.148	.020	.048			.051	.048	.022	.036			.06	0.01	
mg/L	T													mg/L	
SODIUM	R	9.5	5.4	7.3										0.1	
mg/L	T													mg/L	
TOTAL SOLIDS	R													1	
mg/L	T													mg/L	
TURBIDITY	R													0.01	1
FTU	T													FTU	FTU
METALS															
ALUMINUM	R													0.003	
mg/L	T													mg/L	
ARSENIC	R													0.001	0.05
mg/L	T													mg/L	mg/L
BARIUM	R													0.001	1
mg/L	T													mg/L	mg/L
BERYLLIUM	R													0.001	
mg/L	T													mg/L	
BORON	R													0.02	5
mg/L	T													mg/L	mg/L
CADMIUM	R													0.0003	0.005
mg/L	T													mg/L	mg/L

TABLE 5.0

MPOS

PLANT UNION WATER SYSTEM WATER QUALITY - 4-YEAR SUMMARY (1983 - 1986)

METALS (Cont'd)		1986			1985			1984			1983			DWSP DETECTION LIMIT*	DRINKING WATER OBJ/ GUIDELINE[1]
		MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE		
SELENIUM	R													0.001	0.01
mg/L	T													mg/L	mg/L
STRONTIUM	R													0.001	
mg/L	T													mg/L	
TIN	R														
(no units available)	T														
URANIUM	R													0.002	.02
mg/L	T													mg/L	mg/L t
VANADIUM	R													0.001	
mg/L	T													mg/L	
ZINC	R													0.001	5
mg/L	T													mg/L	mg/L h
PURGEABLES															
BENZENE	R													1	10
ug/L	T													ug/L	ug/L h
BROMOFORM	R													1	350
ug/L	T													ug/L	ug/L ++
CARBON TETRACHLORIDE	R							0	0	0	0	0	0	1	3
ug/L	T							0	0	0	0	0	0	ug/L	ug/L h
CHLOROBENZENE	R													1	100-300
ug/L	T													ng/L	ng/L h*

TABLE 5.0

MPOS

PLANT UNION WATER SYSTEM WATER QUALITY - 4-YEAR SUMMARY (1983 - 1986)

PURGEABLES (Cont'd)		1986			1985			1984			1983			DWSP DETECTION LIMIT*	DRINKING WATER OBJ/ GUIDELINE[1]
		MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE		
CHLORODIBROMOMETHANE	R	0	0	0	5	0	0	0	0	0	0	0	0	1	350
ug/L	T	5	0	3.5	7	3	4.4	6	0	2.7	4	0	3	ug/L	ug/L ++
CHLOROFORM	R	0	0	0	15	0	1	0	0	0	10	0	2	1	350
ug/L	T	25	6	17	50	9	23	52	0	32	54	28	38	ug/L	ug/L ++
1,2-DICHLOROBENZENE	R													1	400
ug/L	T													ug/L	ug/L e
1,3-DICHLOROBENZENE	R													1	400
ug/L	T													ug/L	ug/L e
1,4-DICHLOROBENZENE	R													1	400
ug/L	T													ug/L	ug/L e
DICHLOROBROMOMETHANE	R	0	0	0	8	0	0	0	0	0	0	0	0	1	350
ug/L	T	11	4	8.5	18	6	12	23	0	14	19	10	13	ug/L	ug/L ++
1,1-DICHLOROETHANE	R													1	
ug/L	T													ug/L	
1,2-DICHLOROETHANE	R													1	10
ug/L	T													ug/L	ug/L h
1,1-DICHLOROETHYLENE	R													1	.3
ug/L	T													ug/L	ug/L h
T,1,2-DICHLOROETHYLENE	R													1	
ug/L	T													ug/L	

TABLE 5.0

WPOS

PLANT UNION WATER SYSTEM WATER QUALITY - 4-YEAR SUMMARY (1983 - 1986)

PURGEABLES (Cont'd)		1986			1985			1984			1983			DWSP DETECTION LIMIT*	DRINKING WATER OBJ/ GUIDELINE[1]
		MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE		
DICHLOROMETHANE	R													5	40
ug/L	T													ug/L	ug/L c
1,2 DICHLOROPROPANE	R													1	
ug/L	T													ug/L	
ETHYLBENZENE	R													1	1400
ug/L	T													ug/L	ug/L e
ETHYLENE DIBROMIDE	R														
ug/L	T														
M-XYLENE	R													1	620
ug/L	T													ug/L	ug/L c
O-XYLENE	R													1 ug/L	620
ug/L	T														ug/L c
P-XYLENE	R													1	620
ug/L	T													ug/L	ug/L c
TOLUENE	R													1	100
ug/L	T													ug/L	ug/L c
1,1,2,2-TETRACHLOROETHANE	R													1	1.7
ug/L	T													ug/L	ug/L e
TETRACHLOROETHYLENE	R							0	0	0	0	0	0	1	10
ug/L	T							0	0	0	0	0	0	ug/L	ug/L h

TABLE 5.0

MPOS

PLANT UNION WATER SYSTEM WATER QUALITY - 4-YEAR SUMMARY (1983 - 1986)

PURGEABLES (Cont'd)		1986			1985			1984			1983			DWSP DETECTION LIMIT*	DRINKING WATER OBJ/ GUIDELINE[1]
		MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE		
1,1,1-TRICHLOROETHANE	R													1	1000
ug/L	T													ug/L	ug/L c
1,1,2-TRICHLOROETHANE	R													1	6
ug/L	T													ug/L	ug/L e
TRICHLOROETHYLENE	R							0	0	0	0	0	0	1	30
ug/L	T							0	0	0	0	0	0	ug/L	ug/L h
TOTAL TRIHALOMETHANES	R													3	350
ug/L	T													ug/L	ug/L ++
TRIFLUOROCHLOROTOLUENE	R													1	
ug/L	T													ug/L	
ORGANOCHLORINES															
ALDRIN	R													1	700
ng/L	T													ng/L	ng/L **
ALPHA BHC	R													1	700
ng/L	T													ng/L	ng/L c
ALPHA CHLORDANE	R													2	700
ng/L	T													ng/L	ng/L ***
BETA BHC	R													1	300
ng/L	T													ng/L	ng/L c
DIELDRIN	R													2	700
ng/L	T													ng/L	ng/L **

TABLE 5.0

MPOS

PLANT UNION WATER SYSTEM WATER QUALITY - 4-YEAR SUMMARY (1983 - 1986)

ORGANOCHLORINES (Cont'd)		1986			1985			1984			1983			DWSP DETECTION LIMIT*	DRINKING WATER OBJ/ GUIDELINE[1]
		MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE		
ENDRIN	R													4	200
ng/L	T													ng/L	ng/L
GAMMA CHLORDANE	R													2	700
ng/L	T													ng/L	ng/L ***
HEPTACHLOR EPOXIDE	R													1	3000 +++
ng/L	T													ng/L	ng/L
HEPTACHLOR	R													1	3000
ng/L	T													ng/L	ng/L +++
HEXACHLOROBENZENE	R													1	10
ng/L	T													ng/L	ng/L h
HEXACHLOROBUTADIENE	R														
ug/L	T														
HEXACHLOROETHANE	R													1	19000
ng/L	T													ng/L	ng/L e
LINDANE	R													1	4000
ng/L	T													ng/L	ng/L
METHOXYCHLOR	R													5	100000
ng/L	T													ng/L	ng/L
MIREX	R													5	
ng/L	T													ng/L	

TABLE 5.0

PLANT UNION WATER SYSTEM — WPOS WATER QUALITY - 4-YEAR SUMMARY (1983 - 1986)

ORGANOCHLORINES (Cont'd)		1986 MAX	1986 MIN	1986 AVE	1985 MAX	1985 MIN	1985 AVE	1984 MAX	1984 MIN	1984 AVE	1983 MAX	1983 MIN	1983 AVE	DWSP DETECTION LIMIT*	DRINKING WATER OBJ/ GUIDELINE[1]
OCTACHLOROSTYRENE	R													1	
ng/L	T													ng/L	
O,P-DDT	R													5	30000
ng/L	T													ng/L	ng/L d
OXYCHLORDANE	R													2	
ng/L	T													ng/L	
PCB TOTAL	R													20	3000
ng/L	T													ng/L	ng/L t
PENTACHLOROBENZENE	R													1	74000
ng/L	T													ng/L	ng/L e
P,P-DDD	R													5	d
ng/L	T													ng/L	
P,P-DDE	R													1	d
ng/L	T													ng/L	
P,P-DDT	R													5	d
ng/L	T													ng/L	
1,2,3,4-TETRACHLOROBENZENE	R													1	
ng/L	T													ng/L	
1,2,3,5-TETRACHLOROBENZENE	R													1	
ng/L	T													ng/L	

TABLE 5.0

PLANT UNION WATER SYSTEM MPOS WATER QUALITY - 4-YEAR SUMMARY (1983 - 1986)

ORGANOCHLORINES (Cont'd)		1986 MAX	1986 MIN	1986 AVE	1985 MAX	1985 MIN	1985 AVE	1984 MAX	1984 MIN	1984 AVE	1983 MAX	1983 MIN	1983 AVE	DWSP DETECTION LIMIT*	DRINKING WATER OBJ/ GUIDELINE[1]
1,2,4,5-TETRACHLOROBENZENE	R													1	38000
ng/L	T													ng/L	ng/L e
THIODAN I	R													2	74000
ng/L	T													ng/L	ng/L ea
THIODAN II	R													4	74000
ng/L	T													ng/L	ng/L ea
THIODAN SULPHATE	R													4	
ng/L	T													ng/L	
TOXAPHENE	R														
(no units available)	T														
1,2,3-TRICHLOROBENZENE	R													5	10000
ng/L	T													ng/L	ng/L y
1,2,4-TRICHLOROBENZENE	R													5	15000
ng/L	T													ng/L	ng/L y
1,3,5-TRICHLOROBENZENE	R													5	10000
ng/L	T													ng/L	ng/L y
2,3,6-TRICHLOROTOLUENE	R													5	
ng/L	T													ng/L	
2,4,5-TRICHLOROTOLUENE	R													5	10000
ng/L	T													ng/L	ng/L g

TABLE 5.0

WPOS

PLANT UNION WATER SYSTEM WATER QUALITY - 4-YEAR SUMMARY (1983 - 1986)

TRIAZINES		1986			1985			1984			1983			DWSP DETECTION LIMIT*	DRINKING WATER OBJ/ GUIDELINE[1]
		MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE		
TRIAZINES															
2,6,A-TRICHLOROTOLUENE	R													5	
ng/L	T													ng/L	
ALACHLOR	R	<50	<50	<50											
ng/L	T														
AMETRINE	R	<50	<50	<50										50	
ng/L	T													ng/L	
ATRATONE	R	130	<50	<50											
ng/L	T														
ATRAZINE	R	2440	<50	219										50	46000
ng/L	T													ng/L	ng/L !
BLADEX	R	215	<100	115										100	10000
ng/L	T													ng/L	ng/L !
METOLACHLOR	R	<500	<500	< 500											
ng/L	T														
PROMETONE	R	70	<50	<50										50	
ng/L	T													ng/L	
PROMETRYNE	R	<50	<50	<50										50	1000
ng/L	T													ng/L	ng/L !
PROPAZINE	R	<50	<50	< 50										50	
ng/L	T													ng/L	

TABLE 5.0

MPOS

PLANT UNION WATER SYSTEM WATER QUALITY - 4-YEAR SUMMARY (1983 - 1986)

TRIAZINES (Cont'd)		1986			1985			1984			1983			DWSP DETECTION LIMIT*	DRINKING WATER OBJ/ GUIDELINE[1]
		MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE		
SENCOR	R	<100	<100	<100										100	
ng/L	T													ng/L	
SIMAZINE	R	<50	<50	<50										50	10000
ng/L	T													ng/L	ng/L l
SPECIAL PESTICIDES															
2,4-D	R													100	100000
ng/L	T													ng/L	ng/L
2,4-D BUTYRIC ACID	R													200	18000
ng/L	T													ng/L	ng/L l
DICAMBA	R													100	87000
ng/L	T													ng/L	ng/L l
PENTACHLOROPHENOL	R													50	10000
ng/L	T													ng/L	ng/L h
PICLORAM	R													100	
ng/L	T													ng/L	
2,4-D PROPIONIC ACID	R													100	
ng/L	T													ng/L	
SILVEX	R													50	10000
ng/L	T													ng/L	ng/L
2,4,5-T	R													50	
ng/L	T													ng/L	

TABLE 5.0

WPOS

PLANT UNION WATER SYSTEM WATER QUALITY - 4-YEAR SUMMARY (1983 - 1986)

SPECIAL PESTICIDES (Cont'd)		1986 MAX	1986 MIN	1986 AVE	1985 MAX	1985 MIN	1985 AVE	1984 MAX	1984 MIN	1984 AVE	1983 MAX	1983 MIN	1983 AVE	DWSP DETECTION LIMIT*	DRINKING WATER OBJ/ GUIDELINE[1]
2,3,4,5-TETRACHLOROPHENOL	R													50	
ng/L	T													ng/L	
2,3,5,6-TETRACHLOROPHENOL	R													50	
ng/L	T													ng/L	
2,3,4-TRICHLOROPHENOL	R													100	
ng/L	T													ng/L	
2,4,5-TRICHLOROPHENOL	R													50	
ng/L	T													ng/L	
2,4,6-TRICHLOROPHENOL	R													50	10000
ng/L	T													ng/L	ng/L h
ORGANOPHOSPHOROUS PESTICIDES															
DIAZINON	R													50	14000
ng/L	T													ng/L	ng/L
DICHLOROVOS	R														
ng/L	T														
DURSBAN	R														
ng/L	T														
ETHION	R														
ng/L	T														
GUTHION	R														
ng/L	T														

TABLE 5.0

MPOS

PLANT UNION WATER SYSTEM WATER QUALITY - 4-YEAR SUMMARY (1983 - 1986)

ORGANOPHOSPHOROUS PESTICIDES (Cont'd)		1986			1985			1984			1983			DWSP DETECTION LIMIT*	DRINKING WATER OBJ/ GUIDELINE[1]
		MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE		
MALATHION	R														
ng/L	T														
METHYLPARATHION	R													50	7000
ng/L	T													ng/L	ng/L
METHYLTRITHION	R														
ng/L	T														
MEVINPHOS	R														
ng/L	T														
PARATHION	R													50	35000
ng/L	T													ng/L	ng/L
PHORBATE	R														
ng/L	T														
RELDAN	R														
ng/L	T														
RONNEL	R														
ng/L	T														
MASS SPEC.															
DI-N-BUTYL PHTHALATE	R													0.1	34000
ug/L	T													ug/L	ug/L e

TABLE 5.0

WPOS

PLANT UNION WATER SYSTEM WATER QUALITY - 4-YEAR SUMMARY (1983 - 1986)

MASS SPEC. (Cont'd)		1986 MAX	1986 MIN	1986 AVE	1985 MAX	1985 MIN	1985 AVE	1984 MAX	1984 MIN	1984 AVE	1983 MAX	1983 MIN	1983 AVE	DWSP DETECTION LIMIT*	DRINKING WATER OBJ/ GUIDELINE[1]
N-DICHLOROMETHYLENE-PENTACHLOROANALINE	R													0.1	
ug/L	T													ug/L	
DIPHENYL ETHER	R													0.1	
ug/L	T													ug/L	
FLUORANTHENE	R													0.1	
ug/L	T													ug/L	
HEXACHLOROPROPENE	R													0.1	
ug/L	T													ug/L	
METHYL PHENANTHRENE	R													0.1	
ug/L	T													ug/L	
NAPHTHALENE	R													0.1	
ug/L	T													ug/L	
PENTACHLOROBUTADIENE	R													0.1	
ug/L	T													ug/L	
PENTACHLOROPROPANE	R													0.1	
ug/L	T													ug/L	
PENTACHLOROPROPENE	R													0.1	
ug/L	T													ug/L	
PYRENE	R													0.1	
ug/L	T													ug/L	

TABLE 5.0

PLANT UNION WATER SYSTEM WPOS WATER QUALITY - 4-YEAR SUMMARY (1983 - 1986)

MASS SPEC. (Cont'd)		1986			1985			1984			1983			DWSP DETECTION LIMIT*	DRINKING WATER OBJ/ GUIDELINE[1]
		MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE		
TETRACHLORBUTANE ug/L	R T													0.1 ug/L	
TETRACHLOROBIPHENYL ug/L	R T													0.1 ug/L	
BACTERIA															
RAW WATER:															
TOTAL COLIFORM MF	R														
TOTAL COLIFORM BKGD	R														
FECAL COLIFORM MF count/100mL	R													0	0/0.1 mL
STANDARD PLATE COUNT MF count/mL	R													0	500
TREATED WATER:															
PRESENT/ABSENT TEST	T														
TOTAL COLIFORM BACKGROUND MF count/100mL	T													0	OWDO Bacti
FECAL COLIFORM MF count/100mL	T													0	ODWO Bacti

TABLE 5.0

PLANT UNION WATER SYSTEM WPOS WATER QUALITY - 4-YEAR SUMMARY (1983 - 1986)

BACTERIA (Cont'd)		1986			1985			1984			1983			DWSP DETECTION LIMIT*	DRINKING WATER OBJ/ GUIDELINE[1]
		MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE	MAX	MIN	AVE		
TREATED WATER: (Cont'd)															
STANDARD PLATE COUNT MF count/100mL	T														
IF PRESENT/ABSENT TEST POSITIVE:															
COLIFORM P/A	R														
	T														
FECAL COLIFORM P/A	R														
	T														
E. COLI P/A	R														
	T														
AROMONAS P/A	R														
	T														
STAPH. AUREUS P/A	R														
	T														

*If other than DWSP Detection Limit

A0106A/eal

TABLE 6.0: ALGAE COUNT

NO DATA AVAILABLE

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 7.0: BACTERIOLOGICAL TESTING 1983

		TOTAL COLI				FECAL COLI				FECAL STREP			
		A	B	C	D	A	E	F	G	A	H	I	J
JAN	R		0	0			0				0	0	
	T	0				0							
FEB	R		0	0			0	0			0		0
	T	0				0							
MAR	R		0	0			0	0			0	0	0
	T	0				0							
APR	R		0	0			0	0			0	0	
	T	0				0							
MAY	R		0	0			0	0			0		0
	T	0				0							
JUN	R		0	0			0	0			0	0	
	T	0				0							
JUL	R		0	0			0	0			0	0	
	T	0				0							
AUG	R		8	0			8	0			1	2	
	T	8				5				2			
SEP	R		6	0			5	1			1	0	1
	T	6				4							
OCT	R		5	2			3	3				3	0
	T	7				6							
NOV	R		4	2			3	3			1	0	1
	T	6				4							
DEC	R		1	4			5	0			0	0	2
	T	5				3							

ALL RESULTS ARE FOR 100mL SAMPLES;
TESTS CARRIED OUT AT MOE LAB, LONDON
AND WINDSOR MOH LAB

A = ABSENT
B = 1-100
C = 101-5000
D = >5000
E = 0-10
F = 11-500
G = >500
H = 0-1
I = 2-50
J = >50

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 7.0: BACTERIOLOGICAL TESTING 1984

		TOTAL COLI				FECAL COLI				FECAL STREP			
		A	B	C	D	A	E	F	G	A	H	I	J
JAN	R		8	0			8	0			3	0	0
	T	8				5							
FEB	R		5	1			5	1			0	2	0
	T	6				4							
MAR	R		4	2			4	2			1	0	1
	T	6				4							
APR	R		7	0	0		7	0			2		0
	T	7				5							
MAY	R		6				6				2	0	
	T	6				4							
JUN	R		6				6				0	2	
	T	6				4							
JUL	R		8	0			8	0			2	1	
	T	8				5				1			
AUG	R		5	1			6	0	0		1	1	0
	T	6				4							
SEP	R		6	0			5	1			1	1	
	T	6				4							
OCT	R		7	0			7	0			1	1	
	T	7				5							
NOV	R		5	1				2				2	0
	T	5				4							
DEC	R		5	0			3	2				2	0
	T	5				3							

ALL RESULTS ARE FOR 100mL SAMPLES;
TESTS CARRIED OUT AT MOE LAB, LONDON
AND WINDSOR MOH LAB

A = ABSENT
B = 1-100
C = 101-5000
D = >5000
E = 0-10
F = 11-500
G = >500
H = 0-1
I = 2-50
J = >50

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 7.0: BACTERIOLOGICAL TESTING 1985

		TOTAL COLI				FECAL COLI				FECAL STREP			
		A	B	C	D	A	E	F	G	A	H	I	J
JAN	R		5	3	0		4	4			0	3	0
	T	8	0			5	0						
FEB	R		4	2			3	3			1	1	0
	T	6				4							
MAR	R		4	2			3	3			1	1	
	T	6				4							
APR	R		3	4			4	3			1	1	
	T	7				5							
MAY	R		5	0			5	0			2	0	0
	T	6				6							
JUN	R		6	0	0		6	0			2	0	0
	T	6				4							
JUL	R		6	2	0		7	1			2	1	0
	T	8				5							
AUG	R		3	1			4	2			2	0	
	T	6				4							
SEP	R		1	1			1	6	0		2	0	0
	T	7				5							
OCT	R		1	2	0		2	2	0			2	0
	T	5				3							
NOV	R		1	1			2	4				2	
	T	6				4							
DEC	R			2				7	0			2	0
	T	7				5							

ALL RESULTS ARE FOR 100mL SAMPLES;
TESTS CARRIED OUT AT MOE LAB, LONDON
AND WINDSOR MOH LAB

A = ABSENT
B = 1-100
C = 101-5000
D = >5000
E = 0-10
F = 11-500
G = >500
H = 0-1
I = 2-50
J = >50

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 7.0: BACTERIOLOGICAL TESTING 1986

		TOTAL COLI				FECAL COLI				FECAL STREP			
		A	B	C	D	A	E	F	G	A	H	I	J
JAN	R		2	0	0		2	4			1	0	0
	T	6	0			4	0						
FEB	R		2	0			2	4			2	0	0
	T	6				4							
MAR	R		2	0			3	3			2	0	
	T	6				4							
APR	R		2	0			2	5			2	0	
	T	7				5							
MAY	R		1	1			1	5			1	1	0
	T	6				4							
JUN	R		0	4	0		2	5			2	1	0
	T	8				5							
JUL	R		1	1	0		2	4			0	2	0
	T	6				4							
AUG	R		0	0			0	0			0	0	
	T	0				0							
SEP	R		0	0			0	0	0		0	0	0
	T	0				0							
OCT	R		0	0	0		0	0	0			0	0
	T	0				0							
NOV	R		0	0			0	0				0	
	T	0				0							
DEC	R			0				0	0			0	0
	T	0				0							

ALL RESULTS ARE FOR 100mL SAMPLES;
TESTS CARRIED OUT AT MOE LAB, LONDON
AND WINDSOR MOH LAB

A = ABSENT
B = 1-100
C = 101-5000
D = >5000
E = 0-10
F = 11-500
G = >500
H = 0-1
I = 2-50
J = >50

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 8.0: ALERT LEVELS (DISTRIBUTION SYSTEM)

DATE	PARAMETER	MEASURED PARAMETER	GUIDELINE LIMIT

No data available.

WATER PLANT OPTIMIZATION STUDY
UNION WATER SYSTEM

TABLE 8.1: ALERT LEVELS (TREATED WATER AT PLANT)

DATE	PARAMETER	MEASURED PARAMETER	GUIDELINE LIMIT

No data available.

APPENDIX D
TERMS OF REFERENCE

Purpose

To review the present conditions and determine an optimum treatment strategy for contaminant removal at the plant, with emphasis on particulate materials and disinfection processes.

Work Tasks

1. Receive an information package from the MOE. Review the information provided and meet with the MOE staff, if required, to discuss the project.

2. Document the quality and quantity of raw and treated waters.

3. Define the present treatment processes and operating procedures. Prepare a progress report on Works Tasks 1-3 for the Project Committee.

4. Assess the methods of efficient particulate removal which would utilize the present major capital works of the plant. Evaluate the particulate removal efficiency and sensitivity of operation, assuming optimum performance of the plant.

5. Assess current disinfection practices and possible improvement methods.

6. Describe possible short and long-term process modifications to obtain optimum disinfection and contaminant removal.

7. Prepare a draft report for the project committee's review.

8. Prepare the final report.

1. RECEIVE AN INFORMATION PACKAGE FROM THE MOE. REVIEW THE INFORMATION PROVIDED AND MEET WITH THE MOE STAFF, IF REQUIRED, TO DISCUSS THE PROJECT.

Elements of Work

(a) Receive an information package from the MOE concerning the plant and the study. This package includes a general terms of reference, a general table of contents for organizing the study in a manner consistent with other plant reports, the WPOS reporting tables and a copy of Ontario Drinking Water Objectives.

(b) Review the information and prepare for a meeting to initiate the work on the project, including preparation of a schedule of manpower and staff committments.

(c) Meet with the MOE to discuss the available data, the terms of reference, and the project staff and work schedule. If a consultant is carrying out more that one study it may not be necessary to meet with the MOE at the start of each study.

2. DOCUMENT THE QUALITY AND QUANTITY OF RAW AND TREATED WATERS.

Elements of Work

(a) Prepare a monthly summary of maximum, minimum, and average flows for the last three consecutive years (Table 1.0). Address any discrepancies which exist between raw and treated flow rates.

(b) Based on the above, briefly review and tabulate for the last three years, the monthly maximum, minimum, and average per capita flow for the total population served by the plant (Table 1.1). Compare the plant data with typical per capita flows for the local region. Indicate major consumers who may influence the figures.

(c) Document the methods of measuring the raw and treated water flow rates.

(d) Summarize, for the last three consecutive years, where available, the raw and treated water; turbidity, colour, residual aluminum/iron, pH, temperature and treatment chemical dosages (other than disinfection and fluoridation). The summary should indicate the monthly daily average and maximum and minimum day (Table 2.0).

For the same three year period, tabulate also the daily average for the typical seasonal months of January, April, July and October as well as other months in which problems with particulate removal occurred (Tables 2). Document enough data to define and evaluate those problems.

Record other data, such as particulate counting, suspended solids, and algae counting (Table 5.0) which could reflect on particulate removal efficiency.

Document the source and methods used in determining all information.

A comparison should be made between the plant and outside laboratory information to ascertain the relative validity of the data. For plant data, emphasis should be given to plant laboratory tests rather than continuous process control instruments.

(e) Summarize for the last three consecutive years, where available, the disinfectant demand, dosages (including all disinfection related chemicals and residuals) for all application points as well as fluoridation dosage and residual. The summary should indicate the monthly daily average and maximum and minimum day (Table 3.0).

For the same three year period, tabulate (Tables 3) the daily average for the typical seasonal months of January, April, July and October as well as other months in which problems with chlorine residuals and/or positive bacterial tests identified in Table 6. Document enough data to define and evaluate those problems.

Document the methods of dosage evaluation and residual measurements, and establish the validity of the data provided.

(f) Prepare a summary, based on at least three years of data, of the raw and treated water quality testing data for physical, microbiological, radiological, and chemical water quality information (Table 4). Document as much data as is needed to show possible seasonal trends in water quality. Where possible, show corresponding sets of raw and treated water quality information.

Document the source and methods used in determining all water quality information and establish the validity of the data, comparing plant and outside laboratory data.

(g) Tabulate, for the last three consecutive years, the raw and treated water bacterial test information at the plant (Table 6).

Document the source and methods used for all data provided.

(h) Document the water sampling systems (source, pump, line-material and size, vertical rise velocity sampling location) used in the plant (similar to DWSP Questionnaire in Appendix A).

(i) Prepare a summary of inplant testing including Test, Sampling Point, Testing Frequency, Reporting Frequency, Testing Instrumentation including calibration.

(j) Identify other water quality concerns, not related to particulate removal or disinfection, which should be considered as part of the assessment phase of this evaluation program.

3. DEFINE THE PRESENT TREATMENT PROCESSES AND OPERATING PROCEDURES. PREPARE A PROGRESS REPORT ON WORK TASKS 1-3 (8 COPIES), FOR THE PROJECT COMMITTEE.

Elements of Work

(a) Where drawings are available, assemble sufficient record drawings of a reduced size, to document the general site layout and the interrelationship of major plant components. If available, include a process and piping diagram (PAPD) of the plant operations.

(b) Prepare a simplified block schematic of all major plant components including chemical systems and indicating design parameters. Appendix B is an example of the required standard schematic.

(c) Prepare a photographic record of the plant facilities, illustrating all of the major plant components and chemical feed systems. The record should include approximately 30-40 coloured (9 cm x 12 cm) (or 10 cm x 15 cm) prints, suitably labelled. The progress and draft reports may include photocopies in lieu of the prints.

(d) Tabulate the design parameters for all the major plant components, with emphasis on the process operations, including chemical feeds. This information, as a minimum, must be consistent with the OWSP Questionnaire (Appendix A) and must be confirmed and verified by field observations. The design parameters should be evaluated at design, rated and actual operational flows.

(e) Prepare a summary of how the plant is operated, including chemical dosage control, such as jar testing information, filter backwashing procedures and initiation, and pumping and flow control.

(f) Document all reported and other apparent problems in plant operations and/or in the distribution system related to water quality. In addition list the health related parameters which exceed the Ontario Drinking Water Objectives (Table 7).

(g) Submit 8 copies of the progress report to the Prime Consultant for distribution to the Project Committee.

4. ASSESS THE METHODS OF EFFICIENT PARTICULATE REMOVAL WHICH WOULD UTILIZE THE PRESENT MAJOR CAPITAL WORKS OF THE PLANT. EVALUATE THE PARTICULATE REMOVAL EFFICIENCY AND SENSITIVITY OF OPERATION, ASSUMING OPTIMUM PERFORMANCE OF THE PLANT.

Elements of Work

(a) Assess the validity and implication of all information relating to particulate removal provided in Work Tasks 1 and 2 with emphasis on method, metering and sampling, etc.

(b) Using information provided in Work Tasks 1, 2 and 3 evaluate the plant's particulate removal efficiency. The basis of minimum particulate removal should be 1.0 F.t.u. It should, however, be recognized that it is desirable to strive for an operational level which is as low as is achievable.

(c) Conduct an evaluation of possible optimum performance alternatives. Include jar testing using established industry practice.

(d) Evaluate the feasibility of optimum removal using the existing plant capital works. This evaluation should consider the worst case water quality conditions, even though field testing data may not be available during the initial phase of the study (see Work Task 7).

(e) Describe the operational procedures, management strategies, and equipment required for various feasible alternatives. Estimate chemical dosages, level of operational expertise, and sensitivity of operation of the alternatives.

5. ASSESS CURRENT DISINFECTION PRACTICES AND POSSIBLE IMPROVEMENT METHODS.

Elements of Work

(a) Assess the validity and implication of all information relating to disinfection provided in Work Tasks 1, 2 and 3 with emphasis on method, metering and sampling etc.

(b) Using the information provided in Work Tasks 1, 2 and 3 evaluate the plant's ability to disinfect the water. The basis of minimum disinfection should be to ensure a water quality as described in the Ontario Drinking Water Objectives.

(c) Conduct an evaluation of possible optimum disinfection procedures for the plant, with consideration also given to the reduction of chlorinated by-products in the treated water.

(d) Evaluate the feasibility of the various alternatives using the existing plant capital works.

(e) Assess the relative merits of the alternatives. Describe the operational procedures, management strategies, and equipment required for the feasible alternatives. Estimate chemical dosages, level of operational expertise, and sensitivity of operation for the alternatives.

6. DESCRIBE POSSIBLE SHORT AND LONG-TERM PROCESS MODIFICATIONS TO OBTAIN OPTIMUM DISINFECTION AND CONTAMINANT REMOVAL.

Elements of Work

(a) Prepare a list of modifications which should be considered for detailed implementation evaluation. Provide an estimated cost and possible schedule for implementation for each of the proposed modifications.

It is not the purpose of this study to provide a detailed implementation scheme for plant rehabilitation. It is, however, necessary to scope the feasible short and long-term process modifications required to achieve optimum disinfection and contaminant removals.

(b) Incorporate (a) above in the draft report.

7. PREPARE A DRAFT REPORT FOR THE PROJECT COMMITTEE'S REVIEW. (8 COPIES).

Elements of Work

(a) The report must include all information for Work Tasks 1-6.

The information must be organized and presented in a logical and co-ordinated fashion. A general table of contents (Appendix C) is provided for organizing the material in a manner consistent with other plant reports.

Submit the draft report for review by the Project Committee.

(b) Meet with the Project Committee on site at least one week after submission of the report.

(c) Prepare a separate letter report containing recommendation(s) concerning the need for additional field testing to cover quality conditions not available during the period of this study. The Project Committee may decide to delay completion of the final report until field data can be obtained to confirm the predictions of performance for the worst case water conditions.

8. PREPARE THE FINAL REPORT.

Elements of Work

(a) Conduct additional field testing if required. Discuss the implementations of the results with the Project Committee if the results differ from the predicted performance.

(b) Amend the report as per review comments, incorporating additional field data if required.

(c) Submit 25 copies of the final reports (including the colour photographs) to the MOE for distribution.

(7692)
TD/227/L43/L43/MOE